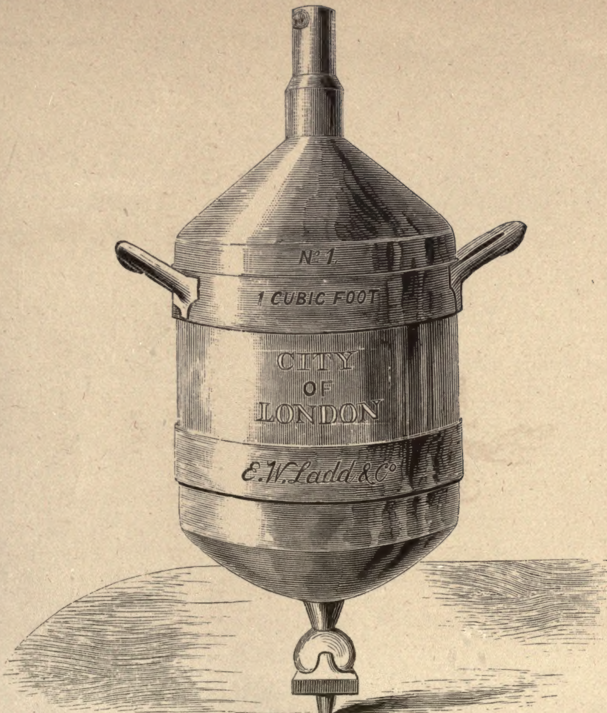
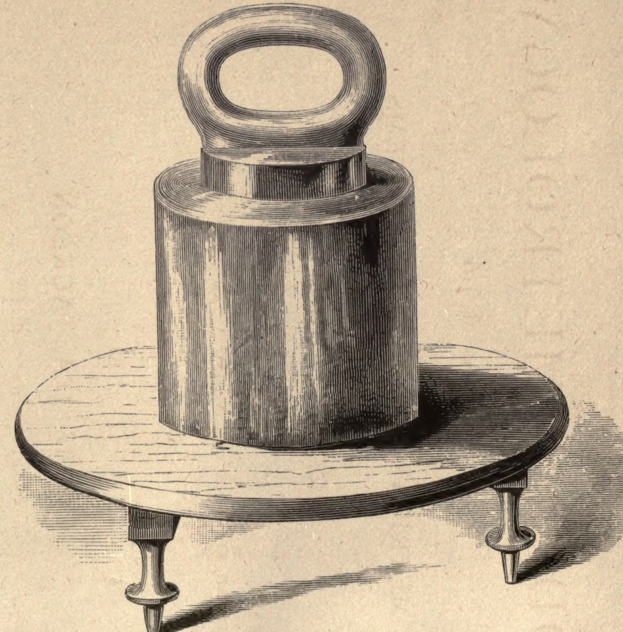
MODERN METROLOGY



THE STANDARD CUBIC-FOOT.

Tinned-copper bottle. Verified by Airy, 1859.



THE STANDARD FOOT-WEIGHT.

Gun-metal cylinder. Verified by Miller, 1859.

MODERN METROLOGY

A MANUAL OF THE

METRICAL UNITS AND SYSTEMS

OF THE

PRESENT CENTURY

WITH AN APPENDIX CONTAINING A PROPOSED ENGLISH SYSTEM

BY

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TO THE

RIGHT HONOURABLE

WILLIAM EWART GLADSTONE

THESE LABOURS ARE INSCRIBED

IN RECOGNITION OF THE INTEREST TAKEN BY HIM IN THE

IMPROVEMENT OF ENGLISH WEIGHTS AND MEASURES

INTRODUCTION.

MEASURES, as exemplified in the pecks, pots and pounds of the tradesman, may at the onset appear uninviting and uninteresting from the fact of their being generally associated with small shopping transactions. The subject, however, even in the smallest of its bearings, cannot be viewed with indifference.

Among almost all nations, an adherence to the customary measures of the people is generally a deep-rooted sentiment much akin to conformity to habitual forms of religious ceremony, old political institutions, and ancient modes of linguistic expression. Such conservatism is a habit of the masses, including preponderating numbers of unreflecting and narrow-minded persons; while the opposite phase of thought and tendency, progress and improvement, constitute the aim of the more enlightened and the scientific; the balance between the two is much affected by temporary circumstances, and controlled by fitful impulse. Change is sometimes considered harassing, sometimes eagerly welcomed. Any important alteration in the measures of a country cannot be unattended with some difficulty; while the adoption of foreign measures, and the abolition of the indigenous measures,

nearly amounts to a national disgrace from the implied admission that the nation cannot devise or produce a sufficiently good system for itself.

Measures are essentially national, and it is in this respect that they are chiefly of interest.

There is, perhaps, no more rapid and certain mode of tracing the influence of a race than through the adoption of its measures. Language may vary in districts, in families, and in individuals; habits and customs, even modes of construction and of destruction, may follow diverse lines within very circumscribed areas; but measures take the most condensed form in which a nation can indicate its peculiarity.

A collection of the measures of all nations constitutes in one form an annal of the world, and metrology in the same way corresponds to history; in this respect measures become scientifically interesting.

Ancient metrology has its votaries, some that like it for itself, others that explore it for its scientific interest as the foundation of modern and of present measures, and as throwing light on probable future development. Useful and indispensable though it may be in some respects, it is yet too antiquarian and frequently too vague to command many followers.

Modern metrology, on the contrary, forms a branch of ordinary education, and supplies part of the stock of general knowledge that every well-informed man should possess. If it is incumbent on the masses that their children should learn at school the measures, or as they are commonly termed, the weights[1] and measures, of

[1] It is an unfortunate and irrational English mode of expression to

their native country, it is no less requisite that the more highly educated should have some knowledge of the measures of all countries.

Books on the subject are few, and frequently have the defects of being unnecessarily and repulsively dry, as well as highly inaccurate and incorrect. As regards dryness, probably nothing can equal the repulsiveness of a column or set of measures unaccompanied by any explanation of the purposes, history, or mode of formation or subdivision; perhaps, however, a column of difficult words in a child's spelling-book, without any account of their derivations, or illustration of their meanings, forms an analogous case. With reference to incorrectness, this may be of two kinds, one due to simple errors and clerical mistakes both on the part of the author and of the printer: the other due to mistaken principles. The revision and seeing through press of such books constitutes a formidable undertaking, which should properly involve working-out and re-checking every figure, a labour most often neglected not only on account of the toil, but because press-corrections are exceedingly expensive and charged on elastic principles; while the general public estimate the value of a book less according to the value of its information and the labour involved in its production, than by its weight of paper, size of type, and other small details.

speak of a measure of weight, or unit of weight, as an actual weight. A measure of anything, whether of power, elasticity, heat, weight or distance, should never be confounded either with the amount or with the quality estimated. The clerk that refers in anecdote to a cow as 'my gentleman' is not more illogical or inaccurate than those that adopt the term weight to represent a unit or a measure of weight.

The errors due to mistaken principles generally may be ascribed to the following causes.

The values of units of measure are sometimes compiled from the first available book, regardless of the probable time, mode, or circumstances under which the comparison of the standard unit was effected, and the number of figures to which the value may be safely relied on. If, as is often the case, the original comparison was made in foreign units, the multiples of a converted value are then liable to an error amounting to a multiple of the primary error in conversion. Next, as a great number of comparisons have been made with French units at 0° Centigrade in vacuo, and as the English standard commercial temperature is now 62° Fahrenheit, and was formerly 30° Fahrenheit, in air at 30″ barometer, allowances for the change of temperature and displacement of air are almost invariably quite neglected; this makes a serious difference in the values of large multiples or units, and may vitiate many pages of units, or even a whole book.

These defects have, as far as possible, been avoided in this work; and, as a rule, English books on the subject have not been made use of. The allowances for temperature, pressure, and air-displacement are the same as in the conversion tables for English and French measures attached to the translation of Kutter's work on velocity-formulæ (London, Spon, 1876), and are very nearly identical with those published later by the Warden of the Standards in the Report for 1872, issued a few years afterwards.

The principal sources of reference and compilation

here utilised are the whole series of Reports of the Warden of the Standards from 1866 to 1878, and Doursther's 'Dictionnaire des Poids et Mesures,' Bruxelles, 1840, a book long out of print, in which sometimes the French values and sometimes the English values are correct; also such information as was collected by myself in Europe, Asia, Africa and America during travel and intervals of professional work, and that due to the kind aid of foreign consulates and embassies in England. In one or two instances a small amount of information may have been taken from sources now forgotten. Some of the Persian measures in Clarke's Persian Manual (London, Allen, 1875), and some of the Japanese and Chinese measures in Browne's 'Merchant's Handbook,' were used at the suggestion of the corresponding embassies; some stray information may also have been gleaned from books of travel.

But, under all circumstances, the whole of the values adopted in this book have been worked out afresh from the basic units believed to be the most correct available. Any values of the multiples of these basic units will necessarily hold with exactitude to the last figure, after allowing for augmentation, only in the original series in which the comparison was made; sometimes, in the French values, sometimes in the English values.

As regards the measures only used actually at the present day, it would be perfectly impossible to distinguish them authoritatively from others that have only lately become nominally obsolete. It may be noticed that legal enactments do not rapidly sweep away old measures, which are liable to survive to a very wide

extent under all circumstances, in spite of comminatory fine and imprisonment. Old measures, too, that may even have become practically as well as legally obsolete, so frequently survive in the language and books of a people, that it becomes convenient to have their values recorded for reference in a book of this sort. The whole of the measures of the present century are therefore included in this collection, excepting the old French and Belgian units, which would require an extra volume; thus, even when any nation has already both adopted French measures and abolished its own by legal enactment, the old measures will be found in the book, and the French system can be referred to in order to obtain the new measures.

The dates of the legal adoption of French measures by various nations will be found in the text (page 14*a*); but those of their actual employment in internal trade to the exclusion of national measures cannot be determined with certainty.

It is a marked feature in the tables of this book that not only are the English commercial or ordinary equivalents of measures given, but also the English scientific equivalents; and this comparative novelty needs special explanation.

The basis of the English scientific system was laid down by the Warden of the Standards in his work 'On the Science of Weighing and Measuring' (London, Macmillan, 1877), where he explains that the English *scientific values* of foreign units are those taken at 32° Fahrenheit in vacuo; and thus form a segregated set of values. Mr. Miller also constructed in 1859 the new English unit

of weight, *the foot-weight or talent,* which is the weight of an English cubic foot of water. These constituted an admirable basis for developing a complete English scientific system, of which full advantage has been taken throughout this work.

Of the necessity for some such complete system there can be no doubt. English commercial measures, being defective in systematisation, are ill-suited to professional, technical, and scientific purposes, while French measures are utterly out of all accord both with English measures and modes and with all other naturally developed systems ; hence neither of them can conveniently answer the purposes of an English scientific or professional man, apart from the undesirability of borrowing foreign measures. An English scientific system must, in order to suit all such purposes, be necessarily either strictly decimal, or mixedly decimal, centesimal and millesimal, as argued in the chapter devoted to the subject, and be in some accord also with ordinary English trade-units.

The complete English scientific system, drawn up on these principles, is given in Part II. chapter vi. with attached conversion tables. It has also been used throughout the whole of the tables as a useful and convenient medium for comparing and computing values of foreign units, without the intervention of French measures.

It is also to a certain extent parallel with the French system, that is, as regards standard temperatures and pressure, and thus forms a convenient medium of calculation for foreigners, to whom English commercial measures are a bugbear of incongruity.

It may also be mentioned, such a permissive professional and scientific system cannot cause any alarm to English shopkeepers that have lately invested in new scales and weights.

Had any other equally perfect and convenient English scientific system been either available or practicable, it would have been adopted in preference ; as the need of some such system in a work of this kind was absolutely pressing.

The general arrangement of this book is in two parts. Part I. can be referred to for the value of any single or detached unit of measure used in the present century ; in this case it is solely necessary to know beforehand whether the unit is one of length, of surface, of cubicity or capacity, or of weight ; it can then be looked for in the corresponding collection and chapter. Part II. includes merely the more common national systems and collections of measures, that are most frequently required ; these are arranged in single pages, so that the whole of the measures of any such nation may be seen at a glance.

The second Part hence involves some repetition of portions of the first Part ; but the arrangement is more suited to rapid reference, and the values of the units are carried to a greater number of figures.

The book has been enlarged by about one-third during its passage through the press, with the object of rendering it more complete than was originally intended.

L. D'A. J.

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,, 151 ,, 18, *for* into three classes *read* under three heads
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and detached, when strong and cosmopolitan, when dismembered and sunk in darkness, or when passing through the various progressive stages either of com-

MODERN METROLOGY.

PART I.—METRICAL UNITS.

CHAPTER I.

PRIMITIVE MEASURES and THEIR DEVELOPMENT.

ALTHOUGH antiquarian research and archaic curiosity are by no means of direct importance in a book that deals with the 'Units and Systems of Measure' of the present century, and occupies itself about their future development, yet the indirect bearing that the experience of ages has produced on the present, and may produce on the future, certainly deserves some notice and consideration. Not only so, but the past development of the apparently very heterogeneous collection of measures of all sorts, that are now and have been in use throughout the world, affords indication of natural transformation suited to the progressive wants of communities, when primitive and detached, when strong and cosmopolitan, when dismembered and sunk in darkness, or when passing through the various progressive stages either of com-

mercial progress or of enlightenment, civilisation and scientific development. This natural transformation, based on rational requirements, is doubtless much obscured in the chaos of measures, of which many are due to unintentional departure from original or from local uniformity ; it existed, nevertheless.

In primitive times, and among nations in a primitive state, there were probably no very definite measures of surface or of capacity like those now used in Europe, but only measures of length and of weight. The measures of length corresponding to the side of a square surface were sufficient for denoting small areas ; while large areas were indicated by natural limits or boundaries, such as rivers, watercourses, the edges of forest, marsh, hill-skirts, borders of natural pasture, or of arable land ; these, in addition to occasional boundary stones or pillars, answered the requirements of the period. Measures of capacity were comparatively rare, almost all commercial and monetary transactions were determined by weight ; measures of weight, either small or large, appear to have always been in existence ; of this there is ample evidence in the customs of Oriental races to this day. In India, and partly in China, grain, oil, and every commodity is sold by weight, while many of the measures of capacity of the Ottoman, as well as those of the East-Asiatic races, are really only transformed measures of weight ; thus a very large number of persons exist in the world to whom a measure of capacity is an unknown and apparently a most useless and cumbrous contrivance.

The primitive measures of length were the grain of corn placed lengthwise, the finger-breadth or digit, the palm-breadth, the span, the foot-length, the cubit (from

the elbow to the finger-tip, and sometimes only to the roots of the finger), the double cubit, the gird or girdle, the fathom (comprised in the reach of the two arms to their fullest extent), the step, the pace or pair of steps, the local acreside of 80 or 100 cubits, or some simple multiple of a small measure, the itinerary measure or mile of 1000 paces, of 4000 cubits, or some convenient multiple of the pace or cubit, and the itinerary distances expressed by the hour's march, and the day's journey. The primitive measures of weight were the weights of various grains of corn, millet, rice, barley, wheat, gunj or abrus (more especially the last on account of their wonderful uniformity in weight); the weights of the current pieces of money locally used; the weight of a certain number of small shells of a sort that happened to be tolerably uniform in size and appearance; the weight of certain stones bearing some certain proportion to that of a number of coins, shells, or grains; the weight of water, oil, wine, rice, wheat or commonly-used grain contained in a temporarily-formed local cubic foot, or in a cubic cubit; the weight of a man (a rather variable quantity), and the load of a man, or of a pack-animal, ass, mule, bullock, or camel.

Such primitive measures in their original condition may now be considered exceedingly variable, but were certainly quite as well suited to the wants of a primitive epoch as modern measures are to modern requirements; for under ordinary circumstances the common commodities of merchandise, grain, oil, &c., were of low value, and when prices were exceptionally high the variation in price was out of all proportion to the fluctuation of unit of measure. The habits of Indian grain-merchants at the present time show an indifference

about units of weight that throws light on the habits of the past in this respect. These merchants, avaricious though they are, will sometimes, on being pressed about their stones and weights being incorrect, volunteer to let one use any weight shown or mentioned, and simply offer a guessed price to suit the case. They can well afford this, for they have the power to get up fictitious famines in districts, and actually do so under the beneficent patronage of the free-trade doctrines of the British Government, that does not interfere with the market-rate, compete with ordinary trade, or aid the helpless native to co-operate against his oppressors. Under such circumstances it is evident the price is everything, while the unit of measure is comparatively immaterial. The same principle would also hold in trade transactions in which measures of length were used. They may now be termed rough measures, but they were amply exact enough. The weight of the pieces of money, whether silver, gold, or electrum—a mixture of the two—were certainly of more importance; monetary weight, in periods when monetary tokens were unknown, or regarded simply as medals, was necessarily the most important part of a system of measures; but even then estimation by apparent weight in the hand, or recognition by some peculiarity of form or of mark, was generally sufficient for this purpose, for this was similarly a consideration far inferior to the genuineness, purity, or quality of the precious metal; a point on which the judgment of any ordinary semi-savage is wonderfully correct.

A second stage in the development of measures is denoted by the demand for greater exactitude; the personal and primitive measures then requiring some

degree of fixity, the personal measures of some chief, king, patriarch, or high-priest then became reduced to actual standards, and were introduced into the temples, the markets, the judgment halls and public buildings, and the people could refer to these for comparison.

In this stage, a cubit was not the cubit of any individual, but had become a standard unit; while the cubit of the individual was merely useful as affording an approximation to the standard unit. Cubic measures, and units of weight based on cubic measure, in preference to arbitrary units, then became possible.

Such standards were few in number, perhaps two of length, and two of weight, one large and one small; while the multiples and submultiples were mere matters of calculation, arrived at in accordance with the habits of thought of the people and their chiefs or priesthood. Some nations, especially the more primitive early Egyptians and the Chinese, counted and thought decimally; others, as the Assyrians, by sixties and sixtieths or shekels; the Romans by twelfths, inches or ounces of land-measure, capacity, length and weight; while the races that obtained the ascendency in modern ages—the Teuton in Europe, and the higher castes or races in India—adhered generally to binary subdivision in their commercial measures, halves, quarters, eighths, and sixteenths, and arranged their multiples so as to admit of it. The subject of systematised modes of subdivision will be treated in another chapter. The natural mode of subdivision was, apart from these methods of counting, based on the natural proportions that the natural units of length, or personal measures, bore to each other.

Taking the digit or finger-breadth as the smallest

common personal unit of length, the proportions of the others to it probably followed nearly the accompanying scale—

1 Palm	= 4	digits
1 Span	= 12	"
1 Foot	= 16	"
1 Cubit	= 24	"
1 Step	= 40	"
1 Pace	= 80	"
1 Fathom	= 96	"
1 Rod	= 160	"

These proportions held generally; the inch or twelfth of a foot, the yard, whether a double cubit, a half-fathom or an actual girdle, and the rod, were probably less ancient units, about which some doubt may exist; but it would be futile to avoid the indication afforded by these proportions, the strong tendency to the convenience of binary and fractional subdivision; while on the other side, the habits of people of a primitive race, aided in counting by the presence of their ten fingers, would naturally tend to the adoption of decimal multiples, as more easily counted.

Apart from such simple or natural measures for ordinary commercial uses, there were also royal measures, and sacred measures, almost invariably larger than the corresponding natural measures. Among coarse uncivilised and ignorant people, size or bulk meant power; an enormous Apis, a heavy bull, conveyed awe; a Saul, being a head and shoulders above the crowd, was elected king and commander-in-chief to manage the war against the Philistines; a celebrated Hindu deity, whose worshippers are millions, is represented by

the figure of a very replete man, with an enormous stomach—quantity then expressed grandeur. Correspondingly also, a large gift or tax paid to the king, or tithe to a priest, conveyed with it an idea of dignity, of sanctity, of reverence, or of special respect. As, also, such increased measures were of considerable advantage to the king or priest, royal and sacred measures were a special institution, involving a separate set of standards, at least for some considerable time before merging into a general combination or into application to separate nationalities or communities.

Besides these temporarily special standard units, there is on record much evidence to the effect that in some cases the units were doubled at pleasure under some monarchs. The inscriptions on the well-known Babylonian and Assyrian bronze and stone lion and duck weights in the British Museum, and the verifications of Mr. Chisholm, show that the manáh or pound under Shalmaneser and some other emperors was double of that under Tiglath-pileser, Nebo-vulibar, Dungi, and Irba-merodach. Double weight, double tribute, and double rent or tax are by no means unknown Oriental arrangements. In years of plenty, a double rent for land is frequently now paid without demur, on the principle that remission accompanies a year of scarcity ; and it is probable that the alteration of the standard weight was a mode of altering taxation without the necessity for altering accounts or issuing edicts that might redound to the advantage rather of the collector than of the king. Fixity of measure was not in those times an admitted necessary principle to the extent of being binding on the government of the country ; even now, in semi-Oriental countries, government paper money is often forced by edict to be accepted

at a very false value, and deemed a justifiable financial proceeding.

Another cause of variety in measure was the tendency of various trades to adopt units of their own, an evident imitation by the tradesmen of the method adopted by the king and the high priest. A single system of commercial measures was thus not only supplemented by royal, sacred, and double measures, but was practically broken up into a mass of special systems; such as a monetary system, a grain and oil or common commercial system, a jeweller's and a precious-stone system, a druggist's; artisans' systems for a large number of crafts, carpentry, masonry, and so on, and finally scientific, astronomical, and geodetic systems. Now, though all such systems doubtless ramified from a single comprehensive system of which they were parts, yet local departure from standard values, engrafted on results in all these sub-systems, inevitably led to complexity.

The overthrow of a dynasty, the influx of a new governing class, might in those ages have produced as much alteration in the measures[1] as now occurs in the names of the streets of Paris under similar conditions; though conquests involving imperialism effected more extended uniformity. This advantage, great as it may appear to persons living in an age of international commerce and rapid communications, was of far less commercial importance in those days; and although it must certainly have been the means of sweeping away a great quantity of local measures, it cannot be assumed that the measures of the conquering were necessarily better than those of the conquered race.

All this variety of standard and modification of units

[1] Exemplified at present in China.

culminating in extreme confusion of measure, naturally necessitated a complete reorganisation, or a fresh departure, after recurrent periods.

In such a development the following stages may be clearly traced :—

1. Primitive personal measures.

2. Primitive standard units, and original systems.

3. Combined and expanded series of measures of great commercial utility.

4. Intricate, confused, and debased measures, heterogeneous in arrangement.

5. Reorganised systems of measures.

After this, the reorganised measures then seem to take the place of primitive standard measures, and the development then repeats itself in the way that history, or rather historic development, invariably does.

The first of these reorganisations (of the measures of the civilised world) of which there is full historic record was the Phileterian system, of the Ptolemaic age, ingeniously devised to suit all purposes in commercial and monetary transactions.

At a later period, there was the Olympic system of Greece, based on the Olympic cubit and Olympic talent, which were identical with the ancient Egyptian natural cubit and the Græco-Egyptian talent ; the subdivision adopted in this system had many advantages as regards simplicity, as well as practical utility, besides that of a rigid adherence to such ancient and correct standard units as were retained.

The Roman reorganisation of measures was a combination of the Egyptian and the Greek modified units, arranged under a fresh system, and a mode of duodecimal subdivision of certain selected primary units of

length, surface, capacity, and weight, which was suited to Roman forms of thought and calculation.

Among more modern reorganisations were that of Charlemagne, about 780 A.D., better known as the French poids de marc system, or pile de Charlemagne (the weights of which are said to have been based on the Arab yusdruman pound of Harun al Rashid); the Nuremberg and the Cöln marc systems, retained for medicinal and for monetary measures of weight until the present age; and the Spanish marc system.

The Anglo-Saxon system, with its Saxon gird or yard, its moneyer's and its marchant's pounds (also having some affinity to the Continental marc), its Saxon acre, and the Roman mile of 5000 Saxon feet engrafted on the system, seems also to have been a complete and well-arranged reorganisation, suited to the period and the wants of the people, at the close of the Heptarchy.

A Scandinavian or a Danish system, about which little information is available, was probably a reorganisation of about the same period.

The Mughal system of Akbar the Great, about 1570, comprised a complete set of weights and measures re-arranged and reorganised from the ancient and surviving Indian measures.

The Russian system of measures, reorganised at the command of Peter the Great, were so arranged that the Russian foot should be exactly identical with the English foot; and the tschetwerik and vedro, the measures of capacity, were, like those of the English, rearranged in accordance with the measure of weight by comparison with distilled water.

In 1795, the whole of the French measures having arrived at an extreme state of heterogeneous confusion, a

new system was adopted, in preference to a reorganisation: a modified half-toise, named a mètre, was adopted as the basic standard unit of length, its length being determined on geodetic considerations, or on an estimated value of the meridional arc passing through Paris then believed to be correct. The system based on this single unit, termed the metric system, was as rigidly decimal as the primitive Chinese or the ancient Egyptian systems, and thus possessed all the advantages of a primitive system, while it was also in strict accordance with the numerical modes of calculation universally adopted, in which the digital system is decimal. The measures of the Netherlands, Greece, and some Italian States being also very heterogeneous and confused, the French metric system was also adopted in those countries at a very early date, to the exclusion of the old measures, and in preference to a reorganisation.

In 1824, the English measures, derived from the Anglo-Saxon system, having become debased and confused from the successive introduction of French measures, the Troy pound, Avoirdupois pound, and French ell, and from a variety of local measures, the whole collection of measures was reorganised, local measures were abolished, and a complete imperial system, based on the greater part of the preferable existing measures, was drawn up with a certain amount of fixity and certainty, and established by law.

In England, in 1869, a new standard-unit of weight was constructed and legalised, the weight of a cubic foot of distilled water represented in commercial weight by 62·321 lbs. The corresponding scientific unit, which corresponds to the ancient Greek talent, and may be termed an English talent, is of extreme importance from

its enabling English scientific and technical calculations to be made and recorded in a purely decimal system, based on the English foot, which possesses all the advantages of the French system, while it is superior to it in its employing a natural unit in common use. The only standard-units necessary in this English scientific system are—

> The foot, as the unit of length ;
> The square foot, as the unit of surface ;
> The cubic foot, as the unit of capacity ;
> The foot-weight, or talent, as the unit of weight—

while the multiples and submultiples are purely decimal in accordance with ordinary arithmetical notation.

Most of the subsidiary units of this system are well-known measures ; the facts, that technical, professional, and scientific men have long utilised the coincidence that the Avoirdupois ounce is very nearly one-thousandth of the foot-weight, and that the fluid-ounce has been long used as a measure of capacity or cubic measure corresponding to the ounce-weight, combine to render such a decimal system convenient. The completion of it worked out throughout this book, and fully explained in the chapter on Scientific Systems, may render its use and application more easy and convenient.

The sets of units are these :—

In length :—the foot, the rod of 10 feet, the chain of 100 feet (Ramsden's), the cable of 10 chains, and the league of 100 chains, or 10000 feet, which is equal to two old London miles. In surface, the square foot, the square rod of 100 square feet, the square chain of 100 square rods, the square cable or century (an old Roman term once well known in England) of 100 square chains,

and the square league of 100 centuries. In weight and cubic measure the two series correspond thus :—

1 rod-weight	=	1000 foot-weight	1 cubic rod	=	1000 cubic feet
1 foot-weight	=	1000 decimal oz.	1 cubic foot	=	1000 fluid-oz.
1 decimal oz.	=	1000 mils	1 fluid-oz.	=	1000 fluid mils
1 mil	=	1000 doits	1 fluid mil	=	1000 fluid doits

The term fluid-ounce has been retained in preference to cubic ounce, cubic decimal inch, or cubic thumb, for the sake of adherence to well-known terms, and because every new term seems a new difficulty to those adopting it. The units themselves cover the whole range of ordinary measures for technical purposes.

A corresponding system based on the inch, including the square inch, cubic inch, and inch-weight, and another based on the yard, including the square yard, cubic yard, and yard-weight, would also be possible, either as detached and purely decimal systems, or in combination with the others ; but would be far less convenient.

The most recent improvement in the English commercial system of measures, declared by Act in 1878, but not yet practically—that is, entirely—effected, is its simplification through the abolition of separate systems of Troy weight and Apothecaries' weight, and consequent reduction of the whole of the commercial weights to a single system.

During a period from about 1859 to the present time, the metric system has been permissively adopted by almost all civilised nations, in addition to the commercial measures of these nations ; thus avoiding the disadvantage and inconvenience inseparable from the rejection of the national measures in common use.

The dates of these permissive enactments in various countries are as follow:—

Spain, Portugal and Italy	1859
England . . . . Act of	1864
United States . . . . „	1866
North German Confederation	1868
Dominion of Canada	1871
Indian Empire, applied only to Officials, Municipalities, and Companies, and solely as regards measures of weight .	1871
Austrian Empire and Switzerland . . .	1873
Sweden and Norway	1875

The compulsory employment of the metric system in France dates from a law passed in 1837.

In Portugal, French measures were actually adopted in their entirety by 1864; in Spain, the compulsory adoption became effective in 1868.

The re-establishment of the German Empire in 1871 led to the necessity for adopting some single system of measures in place of the very various and heretogeneous measures used in the various States and provinces; and, whether local jealousies prevented the extension of the Prussian, or any other existing commercial system to the whole Empire, or other reasons were more influential, the result was the compulsory and exclusive adoption of the metric system in the German Empire from January 1, 1872, and followed by a corresponding change adopted in the Austrian Empire from January 1, 1876.

In 1873, the Canadian Government adopted a decimal system of measures based on English units; these units being the English foot and yard; the English

avoirdupois pound, its decimal multiples and submultiples, from 100 lbs. down to 0·001 lb.; the English grain, its decimal multiples and submultiples, from 1,000 grains to 0·01 grain; the old English Troy ounce, its decimal multiples and submultiples, from 500 Troy oz down to 0·001 Troy oz.; the English cubic foot and its multiples; and the English measures of capacity with their binary subdivision from the bushel to the half-gill.

In colonies, possessions, and dependencies the legal system of measure is generally that of the colonising race or parent-country, but the actual system is practically more often some old system of the parent country, and sometimes a hybrid compromise between old indigenous measures and imported units.

The various typical systems of measure, mentioned as reorganisations in this chapter, will be described in detail in a following part of the book (Part II.).

DATES OF ALTERATIONS IN NATIONAL MEASURES DURING THE PRESENT CENTURY.

DENMARK.

1861. Decimal subdivision of the pound.

SWEDEN AND NORWAY.

1878. French measures adopted by Act of 1875.

ENGLAND.

1824. Reorganisation of measures.
1853. Date of the present primary parliamentary standards.
1859. The foot-weight adopted as a unit of weight.
1864. French measures rendered permissive.
1872. New normal standard temperature 62° Fahrenheit exclusively adopted for trade measures.
1878. Readjustment of measures. Abolition of troy-weight.

France.

1795. Publication of the metric system. Old local measures used till 1812.

1812. Adoption of the mesures usuelles.

1840. Adoption of the simple metric system for commercial purposes.

Germany.

1806. Würtemburg linear measures readjusted.

1810. Baden adopts a modified metric system.

1816. Prussian foot and pound readjusted.

1817. Saxony: Dresden dry measures, and Leipzig weights adopted throughout Saxony.

1818. Darmstadt adopts a modified metric system.

1834. Zollverein units proposed.

1856. Zollverein measures adopted.

1868. French measures permissive. 1872 compulsory.

Netherlands.

1820. French measures adopted with local names.

Belgium.

1836. French denominations of metric measures adopted.

Holland.

1870. French denominations of metric measures adopted.

Austro-Hungary.

1873. French measures permissive. 1876 compulsory.

Russia.

1819. Adjustment of Polish measures on a metric basis.

1826. Readjustment of the Russian Imperial system.

1831. Imperial system adopted in Poland.

Switzerland.

1822. Canton Waadt adopted a modified metric system. Five other cantons partially adopted it.

1873. French measures legally adopted.

Italy.

1803. Lombardo-Venetia adopted French measures.
1840. Naples adopted a geodetic system of measures.
1859. French measures adopted throughout Italy.

Spain.

1859. French measures permissive. 1868 compulsory

Portugal.

1860. French linear units adopted.
1861. French weight units adopted.
1862. French surface units adopted.
1863. French capacity units adopted.

Greece.

1836. French measures adopted with local names, termed Royal measures

Ionian Islands.

1800–1815. Local and Venetian measures in use.
1815–1864. English measures used.
1864. Greek Royal measures adopted.

Europe.

1870. First Conference of the International Standards Commission.

CHAPTER II.

LINEAR MEASURES.

MEASURES of length may be generally divided into three classes :—

1. Ordinary commercial measures from the smallest unit up to the fathom.

2. Agrarian measures, as the rod, the pole, cord, rope, chain, and acreside.

3. Itinerary measures, as furlongs, miles, leagues, stages, and journeys.

THE FOOT.

The Foot is the most general natural standard unit of length retained throughout the civilised world, and for that reason the most important of the natural units still used. There seems little doubt that it was in some countries, but in very primitive times, a primitive unit like the cubit, while in others it was certainly a secondary unit taken in some proportion to cubits already in use as primary units.

The original foot, from which many of the existing European feet has been remotely derived through successive intermediate changes, was probably the ancient Egyptian and the Olympic foot, equal to two-thirds of the natural Egyptian and Olympic cubit ; as

his was the principal foot of the civilised world of ancient times. Its length was nearly 1·013 English foot, and it was probably partly based on geodetic considerations, as, in accordance with the sexagesimal systems then in vogue, it holds the following relation to a roughly estimated mean degree of latitude :—

1 mean degree = 60 minutes ; 1 minute = 6000 feet.

There is, however, an alternative mode of accounting for the derivation. There were several ancient cubits of much greater length than the natural cubit, some of them termed royal cubits ; among them was the Hashemic, or later Arab cubit, of great antiquity, as shown by its identity with the ancient Chaldæan cubit of 2·10 English feet ; and it is very probable that many of the German ells are merely debased Hashemic cubits, which were halved to form the German and European feet of modern times, and doubled to form the German stab and the large French aune.

It is also possible that the European feet may have been derived from various cubits ; but they certainly seem as a rule to be approximations either to halves of royal cubits or to two-thirds of natural cubits of assignable historic origin ; and this same principle seems to hold generally throughout the world, for even the ancient Chinese foot of Hoang Ti, of 0·888 English foot, is said to have some such connexion.

The foreign names of the foot are :—

German : *Fuss, Schuh.*
Dutch and Flemish : *Voet.*
Danish and Norwegian : *Fod.*
Swedish : *Fot.*
Spanish : *pié.*
Italian : *piede.*
French : *pied.*
Portuguese : *pé.*
Chinese : *Chih.*

The values of the feet used since 1800 will be found in the table of equivalents at the end of this section.

The subdivision of the foot.—The Roman subdivisior of the foot into twelfths, or inches, was generally adopted throughout the whole of Europe that fell under Roman sway, and has been retained to the present day ; but in a few provinces and countries, more specially in Belgium, Holland, and parts of France, the inch became the eleventh part of the local foot, possibly with the view of adjusting it to equal the twelfth of some other larger foot ; in a few places also the inch was the tenth of the foot exclusively.

The foot was divided into eleven inches, at the following places :—

Amsterdam.	Boulogne.	Metz.
Anvers.	Caen.	Sedan.
Aisne.	Cambrai.	St. Omer.
Ardennes.	Ghent.	Soissons.
Arras.	Laon.	Tournai.
Bruges.	Normandy.	Vermandois.
Brussels.	Malines.	Vervins.
Beauvais.	Mézières.	

The foot was divided into ten inches at the following places :—

Baden.	Liége.	Tongres.
Carlsruhe.	Louvain.	Vaud.
Cassel.	Luxemburg.	Valais.
Darmstadt.	Maestricht.	Würtemberg.
Hanau.	Mons.	——
Hasselt.	Nassau.	Sweden.
Herenthals.	Nivelles (Belg.)	China.
	Namur.	Japan.

At many places in France and the Netherlands the foot was both divided into eleven inches and into ten inches; and at a few places in France the three modes of subdivision were in use.

The most ancient mode of subdividing the foot was probably decimal, as decimalisation was in vogue in ancient Egypt and in ancient China, as well as in China to the present day; the duodecimal method is more modern, comparatively, but in recent times, both methods have been adopted as suited to various purposes. For geodetical purposes, levelling, and surveying, and all matters in which rapidity and simplicity in calculation is more important than adherence to former measures, the decimal subdivision is more convenient; while in iron-work, where a large amount of plant and of practical construction is in accordance with the true inch or duodecimal system, the latter mode would be preferred from economic considerations. The subdivision of the foot into thirds, or hands, of four inches each, is a method retained to the present time for horse measurement only.

Another mode of subdividing the foot, which is of great antiquity, is into digits, or finger-breadths, which should not be confused with inches; this method is principally applied in Oriental countries to the cubit and double cubit.

The subdivision of the Inch.—The ancient subdivision into thirds, denominated barleycorns, is now generally obsolete; and the subdivision into twelfths or lines is now comparatively rare. The present methods are either binary, into halves, quarters, eighths, and sixteenths, or the decimal subdivision of the inch; the former is almost exclusively adopted in iron-work.

The modern necessity for some smaller unit than either the sixteenth or even the hundredth of an inch has been practically demonstrated by the adoption of various wire-gauges. Although Birmingham wire-gauge was often supposed to be based on some principle of subdivision, or arithmetic or geometric ratio, recent investigation has proved this to be fallacious. The English wire-gauges are purely arbitrary, and even in Birmingham vary greatly according to the maker. In Canada, Stubbs' Birmingham wire-gauge is nearly exclusively adopted; and in France the wire-gauge is in tenths of millimètres. It seems probable that some legal standard wire-gauge will be eventually adopted in England, either in ten-thousandths of a foot, or in thousandths of an inch.

THE CUBIT.

The Cubit has only retained its extreme importance as a primitive unit to the present time in countries and among people that never entirely and exclusively adopted the foot; as some Oriental, Ionian, Asiatic, and African races, that entirely ignore the foot: thus, the pik of Turkey, Arabia, Egypt, Morocco, and of modern Ionian Greece, is a primary unit, so also the hath and hasta, or esto of India, Burma, and of the Malays and Indo-Chinese. Among some semi-Oriental races, or in localities formerly under Oriental sway, the cubit and the foot are both used as distinct units for different purposes, as in Russia, Spain, and Portugal, and their dependencies, where the arsheen and the foot, the codo and the pié, the covado and pé, have been simultaneously employed. In Europe generally, the cubit, as represented by the German ell and the Italian braccio,

was almost exclusively confined to cloth and stuff-measurement, whenever it was not a multiple of the foot, and hence became a measure of secondary importance. In England the cubit is now merely a nominal half-yard; and in France, even under the old system of measures, the cubit or coudée was similarly treated as obsolete, although the long French aunes, corresponding to the German stab, were probably double-cubits by origin; while in Spain there were two cubits, one of half-a-yard, and the other of two feet. In India the hāth or cubit is generally equal to the English cubit, and is used and known as well as the gaz or yard: it has been supposed by some to be a debased Egyptian natural cubit; by others, a correct ancient Hindu hasta, either derived through the Phileterian system or of direct Chaldæan origin.

The Chinese cubit still existing appears not to bear any relation to the principal present Chinese foot, but to an ancient one it bears approximately the same ratio as that shown by the ancient Egyptian cubit to the corresponding foot, namely of three to two.

The cubits of modern times, which alone are treated in this work, consist of the following classes:—

1. The German and Scandinavian ells.

2. The Italian and Levantine bracci.

3. The Spanish and Portuguese codo and covado.

4. The Russian and Turkish arsheens, and the Turkish, Moorish, and Arab piks.

5. The hath, asta, esto, and sok of India and South-Eastern Asia.

Although a great proportion of these measures are nearly obsolete, or have been declared to be so by legislative enactment, they yet happen not to be quite null and void, as measures survive enactments for a consider-

able time, generally to nearly an average lifetime, and sometimes longer; it would hence be a serious omission to neglect mentioning them in a book to which reference might be made in particular cases not of every-day occurrence, and which is intended to deal with the measures of the present century.

The former ells now quite obsolete are those of Flanders and Franche-Comté, or of Belgium and Holland, which varied but slightly, being generally very nearly equal to two and a half local feet, or rather less; the consideration of these may now be neglected entirely. The German and Scandinavian ells may be divided into two sets, those that are or were exactly equal to two local feet, and those that are independent of any convenient ratio or of any well-defined ratio to the local foot. The values of the former may be obtained by reference to the table of German feet in which those marked with an asterisk merely require doubling to give the value of the local ell; the latter set in most instances are less important, generally from having been used in less important towns and from being detached measures of limited application; hence their values are only given in a few special cases. The same remarks apply to the ells of the Austro-Hungarian Empire and of the German cantons of Switzerland.

The English ell, down to the time either of Henry VII. or perhaps of Queen Elizabeth, was always identical with the yard; the Elizabethan ell of 45 English inches was probably an imported modification of some French aune of 44 larger French inches, and is now happily obsolete: the French aune has also been practically obsolete for some time, owing to the facility of replacing it by the mètre. The foreign names

of the ell are: in German and Flemish, *elle*; in Dutch, *el*; in Danish, *alen*; and in Swedish, *åln.*

The Italian bracci, like the Teutonic ells, were mostly used merely for measuring cloth and fabrics of silk and haberdashery, and in a few instances were submultiples of the canna, but in hardly any case have any well-defined ratio to the local foot, when such a foot exists. Sometimes the foot is absent from a local system, or is little used as a submultiple, its place being supplied by the braccio and the canna or pertica, and their submultiples; and this occasional deficiency of the foot, added to the habits and customs of adhering to so-called obsolete measures, renders the braccio not by any means an unknown unit in Italy, at places distant from the principal towns. Its values are hence given in the tables following this chapter. The braccio sometimes is subdivided into 3, and sometimes into $2\frac{1}{2}$ or $2\frac{1}{3}$ palms, the palms being submultiples of the canna; but as a rule the braccio is in practice merely divided into halves or thirds as required. These Italian bracci are entirely distinct from the Spanish and Portuguese braza, braça, and brasada, and the French brasse marine, which are fathoms.

The Spanish codo de ribera, formerly used in the arsenals, was exactly two local feet, while the ordinary codo of commerce was half a vara, or a foot and a half; the Portuguese covado, on the contrary, was not originally a fixed submultiple of the local vara, though it was a double foot. The values of these are given in the tables of linear measures at the end of this chapter.

The Russian arsheen, an Oriental cubit, originally was divided into 32 palez or digits, and was equal to 2·3557 English feet; and at one time it was divided into 2 local feet in a manner corresponding to most of the German

and Scandinavian ells; but as it was also the third of the sasheen, Peter the Great reduced the arsheen to $2\frac{1}{3}$ English feet, thus making the sasheen exactly 7 English feet, and causing the English and the Russian foot to be identical in value. The arsheen is divided into sixteen werschock.

The various Oriental and Levantine piks, or draa, in present use, are said to be mostly derived from the Arabian or Hashemic cubit of Omar, deraga akhdam, of 8 palms or 32 digits, the value of which is estimated to be 2·10 English feet, and from the larger Phileterian cubits, of 8 and of 7 palms, whose values are variously estimated at from 2·433 to 1·83 English feet. The investigation of these various piks seldom leads to very useful trustworthy conclusions; even the pik of the Cairene-Nilometer, now estimated at about 18·19 English inches from recent measurement, was formerly supposed to be identical with the black cubit of the Khalifat, variously stated as 21·26 and 21·34 English inches. The usually-accepted values of the modern piks are given in the tables of linear measure.

The Indian, Indo-Chinese, and Malayan cubits still existing are supposed by some metrologists to have had their common origin in the Arab Hashemic cubit, and their reduced values to be merely due to the degradation of the two ancient cubits of India and of China, which are assumed to have been identical with the former. Whether this is a correct theory, and whether either of those two cubits were Hashemic cubits, is apparently very doubtful. Judging from the facts that the ordinary hāth or Indian cubit, of the present day and for long past, has been 18 English inches, that the Burmese taim has the same value, that the less-used district Indian

cubits rarely exceed 19 English inches, that the Thaï (Siamese) sok is 20 English inches, and the Chinese and Malayan cobid vary between 15 and 20 inches, the above supposition seems hardly tenable.

It is, however, very possible that some special sacred or royal *ancient* Indian hasta, as well as the Royal saundaung of Burma, may be correctly attributed to that origin ; while the ordinary hāth, from being near in value to the Olympic or Egyptian cubit also used by the Phœnicians, may have been brought into the country by Alexander the Great, or by any of the races entering India from the west at any time, or by the maritime and commercial Phœnicians trading with them.

However this cubit may have been introduced, its identity with the English cubit is very remarkable. The double-cubit, or gaz, of India is also identical with the English yard ; the principal distinction consisting in that the Indian hāth is the primary unit, whereas the English yard is, at least at present, the primary unit in the other case ; while the subdivision of the gaz and hāth into inches, in the Roman and English style, is locally unknown in India, although customary in Burma. The ordinary Indian subdivision of the hāth is :—

1 hāth = 2 spans = 8 girah.

Also, 1 hāth = 6 palms = 24 digits or ungli = 72 jao (barleycorns).

Some of these subdivisions are adhered to and some omitted in various provinces and towns, but none of them correspond to the English inch in length.

The Chinese cubit is subdivided decimally ; and the Malayan cubits mostly into halves and quarters.

The values of the various piks, hāths, and other cubits are given in the tables following this section.

THE YARD.

The yard, as known in England, has been considered a purely primitive unit of measure, an Anglo-Saxon girdle, developed into the Winchester yard of King Edgar; but the alternative theory, that it was an approximate double-cubit, adopted during the four centuries of Roman sway, and borrowed from the Romans, is equally tenable. The vara of Spain and of Portugal, which alone correspond to it in Europe, afford indication of support to the latter theory, while the additional argument conveyed by the fact of the ordinary Indian yard or gaz being a recognised double-cubit, and also equal to the English yard, seems entirely conclusive as regards the latter being a double-cubit derived from some source. Its value too indicates that its original cubit either was an Egyptian natural cubit coming through Phœnician traders, or in some other way, or was a Roman cubit (ulna). The analogy afforded by the other English land-measures points to the latter conclusion; the old London mile of 5000 feet or 1000 paces was a Roman mile retained to a very recent epoch, while the actus simplex of the Romans was a rectangle, 120 feet (40 yards) long by 4 feet in width, and the English acre was established by old statute as a rectangle 40 poles in length by 4 in width; an evident similarity in mode which indicates that the Roman double-cubit may have been actually used for measuring land in England for centuries before the Saxon invasion. In the statutes of the Norman dynasty, and even till the time of Henry the Seventh, the term ell (ulna) was applied to the yard, the words being indiscriminately used for the same measure; the aune of France and Normandy being the measure

nearest to the Anglo-Saxon yard known to those that drafted the statutes. It is hence reasonable to imagine that, when the witangemot of King Edgar decreed 'the measure of Winchester shall be the standard,' it enacted in pithy Anglo-Saxon a uniformity that did not previously exist, that the Roman double-cubit and the Saxon gird were till then of different value, but thenceforth rendered identical by adjustment on a Winchester standard. The term *verge* applied to the English yard in the Anglo-Norman statutes does not convey simply a connection between it and the French, Belgian, and Norman verges, these latter being invariably poles of from 16 to 22 feet in length; the term *terra virgata*, or *terre vergée*, in the same way was merely an expression for measured land that was naturally convenient to the Franco-Norman priests that acted as scribes in drawing up enactments at that early period; for they then thought and wrote in accordance with their own ideas; the vergée being a quarter of the Norman acre, as the rood latterly was the quarter of the Anglo-Saxon acre. The more correct term would doubtless have been *terra ulnata*, as in England it was the Roman double-ell that had been principally and for long time the land-measure, and not especially a *mesure d'aunage*, or cloth-measure; an arrangement exactly the reverse of the French custom.

The subdivision of this compounded yard and double ell was necessarily two-fold, one, the Roman mode, dividing it into 3 feet or 36 inches; the other, the Saxon method of natural application to a girdle measure, by the folding and successive halving the girdle length, and thus producing sixteenths; both these modes are adopted in the exchequer standard yard of Henry VII.

The complete series of subdivisions in accordance with English tradition is :—

1 yard = 2 cubits = 3 feet = 4 spans = 9 hands
= 12 palms = 16 nails = 36 inches = 108 barleycorns.

The Spanish vara, which alone among the measures of Europe corresponds exactly to the English yard, was about as much shorter than the Roman double-cubit as the English yard was longer, but was not divided into sixteenths, the mode of subdivision being :—

1 vara = 2 codos = 3 piés = 4 palmos = 36 pulgadas = 48 dedos, or digits.

The Portuguese vara was a measure less neatly systematised, being thus :—

1 vara = 1$\frac{2}{3}$ covado = 5 palmos de craveira ;

the covado, or perhaps the palmo, being the more primitive and ordinary unit, one covado being equal to three palmos, 24 pollegadas, or 36 dedos.

It may be noticed that the palmo of Spain, Italy, and the palme of Southern France is not a palm but a span.

The Indian gaz is not only a distinct double-cubit identical in value with the English yard, but is also divided into sixteenths, in the Anglo-Saxon method ; the habit of measuring with the personal cubit and that of doubling the girdle-length to obtain a measure being still practised.

The ordinary modes of subdividing the common Indian gaz are thus :—

1 gaz = 2 hāth = 4 spans = 12 palms = 24 tassu
= 16 girah = 48 ungli, or digits = 144 jao or barleycorns.

But at some places on the Malabar side the local gaz consisted of $1\frac{1}{2}$ or $1\frac{3}{4}$ hāth, or of a certain number of local tassu ; these being exceptional cases.

The geza or gaz of Persia and Arabia differ greatly from the Indian gaz.

The values of all the secondary measures corresponding to the English yard will be found grouped in one set in the tables at the end of this section.

Considering the yard as a double-cubit it may be said to correspond in this respect to the stab or double-ell of Germany and the large French aune, also a double-ell ; the values of these will not be found in the tables, as those of the stab can be easily deduced from the ells by multiplying them by two, and in many cases from the feet by multiplying them by four ; while the French aunes may be considered not only as perfectly obsolete since 1840, but as possessing no further interest.

THE FATHOM.

The primitive personal fathom was the natural measure applied to a cord in measuring it with the extended arms to the fullest extent, nearly equal to a man's height ; convenience developed this either into lengths marked along the cord, or into short rods or canes of fixed length for enabling it to be done. The fathom or cane, when systematised in a series of measures, was eventually made some simple multiple either of the local foot, or the cubit ; in a few cases of the local span ; and in occasional but comparatively rare instances it was made identical with the pace or double-step.

The fathom being thus a secondary unit in almost all systems, it merely becomes necessary here to give the ratio that it bears to the primary unit.

In England the fathom is now treated as a sounding measure of six feet, subdivided in practice to quarters, and termed the common fathom; the distinctive nautical fathom being a decimal submultiple of the nautical mile, and cable-length, thus: 1 nautical mile = 10 cables = 1000 nautical fathoms, this fathom being about $\frac{1}{80}$ or an inch longer than the common fathom.

The foreign names of the fathom are:—

German: *Faden*, *Klafter*, *Lachter*, *Dumpflachter.*
Dutch: *Vaam.*
Flemish: *Vaem.*
Danish: *Favn.*
Swedish: *Famn.*
French: *Brasse marine*, *Toise.*
Spanish: *Braza*, *Estado*, *Brazada*, *Toesa.*
Portuguese: *Braça*, *Toesa.*
Italian: *Cavezzo*, *Trabucco*, *Canna*, *Pertica*, *Tesa*, *Bracciata.*
Russian: *Faden*, *Sasheen.*
Polish: *Sazen.*
Hindī: *Danda.*
Chinese: *Pu.*
Japanese: *Ikje.*
Thaï (Siam): *Wa.*
Malayan: *Depah.*

In Europe generally the fathom is not merely a sounding-measure, but also used in land-measure, and for works of construction; sometimes having different names in accordance with its mode of use, and sometimes also having different values when applied in these various ways.

Its proportions are or were thus:—

In Germany and Austria the faden and klafter were merely different names for the same unit, consisting of 6 local feet; and in Holland, Belgium, Denmark, and Sweden, the fathoms or toises were all of 6 local feet. The exceptions are the modern klafter of Darmstadt of

10 local feet; the lachter used in mines, which is $6\frac{2}{3}$ local feet in Prussia and 7 local feet in Saxony; and the Bohemian dumpflachter, 4 Bohemian ells.

In France generally, under the old system, the brasse marine was 5 local feet, but the toise 6 local feet; in Burgundy the toise was $7\frac{1}{2}$ local feet, and in some few places $5\frac{1}{2}$, $6\frac{1}{2}$, 7, or even 8 local feet. In Spain, the estado, braza, brazada, and toesa, were all names for a measure of 6 local feet; but the brazada of the Canaries was $6\frac{1}{2}$ local feet. In Portugal the braça as a sounding-measure was 5 local feet, but was also termed either a braça or a toesa for other purposes when it was a measure consisting of 2 local varas or $6\frac{2}{3}$ local feet. In some parts of Switzerland the klafter or toise was 8 local feet, and in others the toise was also the perch and consisted of 10 local feet. The Italian fathom, generally termed the cavezzo, but taking the name trabucco in Piedmont, Nice, and Sardinia, is almost invariably equal to 6 local feet; the exceptions are the cavezzi of Florence and of Mantua, equal to 6 local bracci, and the trabucchi of Nice and of Sardinia, equal to 12 local spans (palmi). The sasheen of Russian land-measure is 7 Russian or English feet, but there is also a fathom identical with the English fathom. The Polish sazen is reputed to have been 6 local feet.

The Chinese pu is the pace of 5 Chinese feet with which the national fathom is identical. The ink or tattami of Japan, also a pace, is equal to 6·2355 English feet; and the ikje of commerce and cloth-measure is nearly 7 English feet, a long fathom. The wa of Thaï (Siam) of 4 local cubits is equal to $6\frac{2}{3}$ English feet, and the depah of Sumatra, Prince of Wales Island, and some other places in the Malayan Archipelago, is equal to the

English fathom, and is subdivided into 8 spans (jaukal). The Indian danda was $2\frac{1}{2}$ local gaz.

Among all these fathoms, the French toise holds the prominent place of affording the origin of a new system of measures; the half-toise, slightly modified and named a mètre, having been made the basic unit of the metric system, hereafter described.

The proportions of the whole of this series of fathoms, or measures corresponding to the fathom, being here given, their actual values may be easily calculated from the values of the foot, or of the cubit or yard, given in the tables, excepting in one case, that of the Italian canna or pertica, which bears no direct proportion either to the bracci or the piede, and cannot be termed a perch in the general sense of the term, which indicates a much larger measure. This measure, termed the canna in commerce and pertica in land-measurement, was exceedingly variable in value all over Italy; it was generally equal to 8 local spans (palmi), in a few places equal to 7 spans, $7\frac{1}{3}$, $7\frac{1}{2}$, or $7\frac{2}{3}$ spans, and in Sardinia 10 spans; at Rome and at Florence the canna of commerce was 8 spans, but the canna of works of construction and buildings 10 spans; the tesa of Savoy was 6 Chambéri feet, and the Neapolitan bracciata was simply a French brasse marine of 5 French pieds du roi. This detail would not be worthy of mention, so long after the Italians have adopted the metric system, were it not a land-measure, and on account of the long survival that so-called obsolete land-measures pre-eminently enjoy. There seems however, to have been no need for these incongruous Italian canne or pertiche, as the Italian cavezzi and trabucchi, which were convenient measures used all over Italy for the same purpose, and also multiples of bracci or piede, could always be made to take their place.

THE ROD AND THE POLE.

The rod, rood, pole, perch, lug, are various names applied to large linear measures of land-measure, that sufficiently indicate their origin; the values of measures of this type, when distinct from fathoms, generally lie between 10 and 25 local feet, or some approximate corresponding values in cubits or yards. It would, however, be a mistake to imagine that the rod, the pole, and the perch have always been measures of exactly the same sort; there seems little doubt that the *rod* was generally a small unit, a double pace, or double fathom, either 10 or 12 feet, while the *pole* was between 12 and 24 feet.

In Italy the *canna* or rod was a small unit used both for land-measure and cloth-measure, an approximate fathom; the exceptional or large *canne* of Tuscany and Sardinia alone being true rods.

In early English times the rod was probably a Roman pertica of 10 feet, while the pole had its present value as a special English term, and the foreign perch or ruthe was from about 14 to 24 feet; the present English unit is evidently one of compromise, to which the term *pole* is alone strictly applicable.

In England there were formerly several local pole measures, 6 yards, 7 yards, and 8 yards; the pole of $5\frac{1}{2}$ yards or $16\frac{1}{2}$ feet, still remaining, seems to have been adopted not from any advantage it possesses as a linear measure, but because its square, the square pole or perch, the $\frac{1}{160}$th part of the acre, supplied a mode of arriving at the latter through calculation, in a method analogous to the Roman mode of deriving the actus quadratus.

At present the English linear pole may be considered

a practically obsolete measure as far as surveyors are concerned, besides being an inconvenient and unnecessary unit of calculation. It seems even very doubtful whether a linear pole of any other length would not be also an entirely needless intermediate unit of calculation.

For the practical purposes of measuring land with deal rods under ordinary circumstances, rods of 10 feet are most convenient, as shown by the demands of Canada for numerous 10-feet standards mentioned in the reports of the Warden of the Standards for the last 10 years; but rod-measurement being less rapid than chaining, the latter mode of measuring has generally superseded the former; and the rod is hence mostly used merely for taking offsets in surveying. The term *rod*, though under old legal statute applicable to the pole, is actually more often applied to the 10-foot rod, which is the tenth of the Ramsden chain of 100 feet, and forms a convenient intermediate unit in the decimal system of measures based on the English foot. The pole or perch may be considered a mere nominal unit not alone in England, but almost everywhere. In Spain—where they have, as in England, a yard (vara) of 3 local feet, a fathom (estado or braza) of 6 local feet, and a double-fathom (estadal) of 12 local feet corresponding to our rod—the estadal was practically disused both in measurement and in calculation, the vara being the unit of calculation, the braza being occasionally used, and perches almost unknown. In Italy there was, properly speaking, no perch at all that corresponded to European perches, the cavezzi and trabucchi used for the same purpose being fathoms of 6 local feet, while the so-called pertica was really a canna, and merely an approximate fathom of a particularly inconvenient kind, as before explained.

The Russian arsheen used in land-measure is a local fathom, and the perch does not exist; the Japanese ikje is also a local fathom, and the perch is either wanting, undiscoverable, or identical with it.

The foreign terms applied to rods, poles, and perches are—

Germany and Sweden: *Ruthe.*	Polish: *Pretow.*
Dutch and Flemish: *Roede.*	Arabic: *Gassab.*
Danish and Norwegian: *Rode.*	Hindī: *Vansa.*
French, also in Belgium: *Perche* and *Verge.*	Burma: *Dha.*
Italian: *Canna* and *Pertica.*	Sumatra: *Jamba.*
	Chinese: *Chang.*
	Guinea: *Jacktan.*

The German ruthe is also termed a land-ruthe, feld-ruthe, or wald-ruthe, in accordance with the description of land measured, and sometimes varies in value on that account alone. In a few exceptional cases in Germany, the value of the linear ruthe has been unduly forced into prominence by attempts to form on its basis a decimal series of measures, and by forming an additional land-foot from it in that way.

The rods of the following countries and places consisted of 10 local feet or were double paces:—

Baden.	Darmstadt.	Vienna.
Bavaria.	Frankfurt.	Würtemberg.
Denmark and Norway.	Elsass and Lothringen.	Zurich and Basel.
		China.

The rods of Prussia, Franconia, Würzburg, Anspach, and Constance were double fathoms, or equal to 12 local feet.

The gassab or Arab rod is 12 local feet or 8 cubits. The dha of Burma is equal to 7 royal cubits (saundaung) or 12 feet 10 inches of English measure. The jamba of Sumatra is 4 haila, or equals 4 English yards.

The poles of Lithuania, Silesia, and Poland were 15 local feet.

In the following places and provinces the pole was 16 local feet:

Aachen.	Cöln.	Mecklenburg.
Bremen and Hamburg.	Creveld.	Mayence.
Brunswick and Hanover.	Gotha.	Nuremberg.
Coblenz.	Luxemburg.	Pomerania.
	Leipzig.	Weimar.
	Lippe-Detmold.	

Other poles, verges, ruthes, &c., were thus:—

Gotha and Hesse: 14 local feet.	Old Indian Vansa: 10 cubits.
Oldenburg and Paris: 18 local feet.	Normandy: 22 local feet.
	France, generally from 20 to 22 local feet.

The present Dutch roede is 10 mètres, and the perche or ruthe of Baden and the Canton de Vaud is 3 mètres. The metric French perch, adopted in the transition period, was 10 mètres.

THE ROPE OR CORD

The cord or rope is a measure slightly more obsolete than the rod, pole, or perch; in England there were several of these measures, the principal being the cords and ropes of 20 feet and of 25 feet. In Spain the cuerda was either 25 local feet, or 8 local yards (varas).

In Brittany the corde was equal to 4 Parisian fathoms, toises, or 24 Parisian feet, but more correctly was 3 gaules, an old fathom of Brittany ; 80 square cordes went to the journal of Brittany, which slightly exceeded the English acre. The chaînée of Poitiers was equal to the corde of Brittany ; and the chaînée of Tours and other places was equal to 25 Parisian feet ; all these measures being evidently of one type. Although obsolete, this measure is of a convenient length for common rough land-measurement; the cause of its abandonment is doubtless due to the practical inaccuracy of rope-measurement from shrinkage ; but as thick wire or wire-rope would not be open to this objection, would coil easily, and be inexpensive, there is yet some possibility of a future revival of some such measure, from its practical superiority over the pole in point of convenience in every way.

THE CHAIN.

The chain of land-measure varies, or has varied in different parts of the world, from about 50 to 150 feet in length. In England at the present day there are two chains in use, one the so-called Gunter's chain of 4 poles, equal to 22 yards or 66 feet, a submultiple both of the statute mile and the acreside ; the other, the Ramsden chain of 100 feet, suited to the convenience in detail of surveying, arrived at by keeping all measurements in feet and decimal submultiples.

As to the real origin of the former chain, there is little information available about ancient English chains; the old Scotch chain was equal to 24 Scotch ells or 74·4 present English feet ; a more modern one exactly 74 feet ; the old Roman chain (actus) was 24 Roman paces,

or 120 Roman feet; and both the Ptolemaic Phileterian and the Greek chains (amma) were 60 local feet. This last value being near the short English chain, it may be conjectured to have been either an imported Phœnician unit of measure, or a half Roman chain, until readjusted as a multiple of the pole by Gunter.

The long chain was probably a modified Roman chain, as its square is very nearly a rood, but its reintroduction is very modern, probably dating from not long before the time of Ramsden, and the commencement of the Ordnance Survey of England.

The following are the foreign names for the chain:—

German: *Schnur*, *Seil*, *Kette*.
Dutch: *Snoer*.
Polish: *Sznurow*.
French: *chaîne*.
Italian: *catena*.
Spanish: *cadena*.
Thaï: *Sen*.
India: *Tenáb*.

The German chains are said to have been generally 10 rods in length, and, as many of these rods were 10 feet, they were mostly chains of 100 local feet. In other cases they were more, the Danzig seil being 150 local feet; so also the schnur of Kœnigsberg and Pillau. The sznurow of Poland was 150 local feet. The Bohemian wald-seil was 42 local ells, and the weinberg-seil 64 local ells.

The Arab chain is 10 gassab (poles) or 120 local feet; the ancient Indian tenáb was 50 gaz (yards); and the sen of Thaï (Siam) is 20 wa (fathoms) or 80 local cubits (sok). The metric chain, used by nations that have adopted the metric system, is 20 mètres, or, as it is termed by the French, a double-decamètre.

The values of the various fathoms, rods, cords, and

chains, which are in all cases secondary units of linear measurement, can be obtained by treating them as multiples of the foot, or from values given in the table at the end of this chapter.

THE ACRE-SIDE.

The *acre-side*, the rood-side, or the side of the principal measure of surface used by any nation, is often a linear unit of importance in calculation, although very frequently not an acknowledged legal unit, and unfortunately sometimes so entirely lost to sight in the arrangements of a system of measures as to be rendered most incongruous and inconvenient in its relation to other linear measures.

For instance, the English acre-side is—

208·710326 ft. = 69·5701085 yds. = 34·78505425 fathoms
= 12·6491106 poles = 3·1622777 Gunter's chains
= 2·08710326 Ramsden chains.

The English rood-side is—

104·3551629 ft. = 34·7850543 yds. = 17·3925272 fathom
= 6·3245553 rods = 1·5811388 Gunter's chains
= 1·043551629 Ramsden chains.

But in the French system, the side of the hectare is exactly 100 mètres, and the side of the arc is 10 mètres. Even in Sumatra, the linear orlong, or local acre-side corresponding to the square orlong, or local acre, is exactly 20 jambas (local perches) or 80 haila (English yards) in length; while the side of the jamba or local square perch is a linear jamba of 4 hailas.

The side of the Arab feddan is exactly 240 local feet; the side of the Spanish cuadra cuadrada is exactly

150 local varas; the side of the Bavarian tagwerk is exactly 20 perches or 200 local feet, so also is that of the Baden morgen; that of the Piedmontese giornata was 120 local feet, and that of the Mecklenburg acre 10 local perches, or 160 local feet.

The side of the Tyrolese starland is 10 perches or 100 feet. The side of the Venetian migliajo was, like the English acre-side, exceedingly inconvenient, being $\sqrt{1000}$ passi or 31·622776 paces of 5 local feet; although the migliajo itself of 1000 square passi was well arranged with respect to the miglio or mile of 1000 passi; as it formed the thousandth part of the square mile; and this is a typical case illustrating the inconvenience of using thousands in square measure; in the same way as the hectare, are, and square mètre show the advantages of hundreds and myriads for the same purpose. The side of the Darmstadt morgen was 20 klafter or 200 local feet, and several other acre-sides of Germany and France were equal to 10 or to 12 local perches or ruthes, as may be seen by inspecting the table of acres and taking the square roots of the number of square perches and square feet of which they are composed. But the greater part of the remaining acre-sides, &c., in present use do not bear any such convenient relation to other linear measures of the system, so that a record of their values would not be of much use in any calculations.

ITINERARY MEASURES.

THE FURLONG of 40 poles long, unknown by that name out of England, is a modification of the Roman stadium, which was an eighth of the Roman mile, and nearly equal to the Olympic *στάδιον*. There are corre-

sponding estadios in Spain and in Portugal, that are eighths of the national miles, and consist of 125 paces.

The present value of the English furlong adapted to the English statute mile—a modern arrangement—is 132 paces, but as the Old London mile of 1000 paces was the local form of the Roman mile, its former value was 125 paces.

At present it may be termed a mere expression for the eighth of the mile that is in use, and a multiple of a disused pole, but can hardly be considered a measure.

The values of the furlong and estadios may be reduced from the values of the corresponding miles given in the table at the end of this chapter.

THE MILE.—Among the itinerary measures of the civilised world, the mile has, since the Roman period, been the principal and the most important. The mile, considered as a simple measure of distance taken from primitive personal measures, was 1000 paces or pairs of steps; but the mile, in a system of national measures, consisted of 1000 reputed paces or units called paces, which among the Romans was 5 Roman feet, so that the Roman milliarium was 1000 paces or 5000 feet. The Old London mile, which, as well as the rebuilding of London, was due to the Romans, was correspondingly 5000 local feet.

The old Irish mile of 320 Irish perches was 6720 English feet, and the old Scotch mile of 1920 Scotch ells was 5929·6 English feet; there were also several other local miles in England before the modern statute mile of 5280 feet, or 1056 paces, was adopted as the Imperial unit. This last was evidently a systematised mile, arranged to make the mile exactly 320 poles, and the square mile exactly equal to 640 acres—an unfortu-

nate mode of disposition that entirely neglected the consideration of that important unit, the acre-side.

Had the land-mile been made 6000 feet, or 2000 yards, in length, and the acre-side exactly 200 feet instead of 208·7, there would have been exactly 30 acre-sides to the mile, and also exactly 900 acres to the square land-mile ; a preferable arrangement that would have adjusted the whole, altered the acre slightly, and abolished the pole entirely. Such a mile would have been one-fifth longer than the London mile, and easily estimated in calculation ; besides becoming identical with the correct and typical Indian kos of 2000 gaz (yards) of Indo-Germanic origin.

However much the statute mile and its complications may be regretted, there is no doubt that any departure from the original London mile would have entirely altered the type from the milliarium of 1000 paces ; while the change actually made removed the mile from one type without putting it into another class of itinerary, and rendered it an exceptional measure.

Among all the miles of antiquity since the Roman period, no such modification of the type appears to have been ever made. The other type of mile is an itinerary measure roughly approximating in value to a milliarium, such as the Chinese li of 360 paces, or 1800 local feet ; the Russian werst of 500 sasheen, or 3500 feet ; the French kilomètre of 1000 mètres ; and the Indian cos of 2,000 yards ; also the Hebrew Saturday walk of 2000 cubits, or about 4000 feet, which cannot be correctly termed a journey.

The values of the modern miles, that are approximately milliaria of the Roman type, are given in the tables of miles at the end of this chapter ; it will, how-

ever, be noticed that the German stage-miles do not follow this type, and are given separately; the small itinerary measures of some nations are also given apart.

THE LEAGUE appears to be in general an itinerary unit representing an hour's walk, based on the ancient parasang of Chaldæa, Persia, and Arabia, and the later parasangs of Egypt, Asia Minor, and Armenia.

Most of these consisted of 3 local miles, but some of them of 4 local miles. The surviving parasang of modern times, the Turkish agasha, is 3 berri; and the leagues of most modern nations that adopted Roman milliaria are generally 3 miles; among these the English had a league of 3 statute miles, which is not a legal unit at present, and hardly even survives in the language of the people as an expression. The term *league* being hence free, it is proposed (see 'Scientific System') to apply it to a unit of two Old London miles, 10000 feet, or 100 Ramsden chains, which is nearly equal to three kilomètres, and thus to complete the decimal series of measures based on the foot.

The discarded French postal league consisted of two old French miles.

The German stunde is a measure corresponding to the league, conveying the same idea of the hour's walk, and it is very possible that the old stunden of Germany, of which those of Westphalia, Baden, Bavaria, Würtemberg, and Bohemia, retained the longest vitality, were primitive units of itinerary measure in that country, although latterly they have been treated as secondary measures or halves of the large German post-miles or stages.

In countries that were destitute both of an approximate Roman milliarium, and of a stage-measure or post

mile, and any very large itinerary, the hour's walk could neither be a multiple of the one nor a submultiple of the other; as, for instance, the old Flemish and Dutch uer and uur, which were primary measures consisting of 1000 verges or roede, or 20000 local feet. Also the roeneng of Thaï (Siam), of 2000 local fathoms (wa); and the dain of Burma, of 1000 dha or local perches.

The Chinese pôu, consisting of 8 li or nearly 4 English miles, is a league of the secondary description, being a tenth of the tsan or journey.

The values of the primary leagues are given in the table following; but those of most secondary leagues may be obtained either by multiplying the miles (milliaria) by three, or by dividing the German post-miles (stages) by two.

THE STAGE, *post-mile*, gross-mile, or staging-distance of Germany is an itinerary measure not to be confounded with the ordinary miles, or milliaria, before mentioned, as it belongs to an entirely different type. The Teutonic and Scandinavian meil is a stage, or stathm.

Referring to ancient measures, we find a stathm or stage as a unit of measure in use in Syria and Asia Minor, consisting of 6 Egyptian miles; also a stathm used in Persia and Western Asia that was equal to 4 parasangs or leagues, and was therefore nearly 12 miles; the latter stage being very nearly double the former. Now, double measures of many sorts were quite a common institution in Asia in ancient times, and probably also double stages; also there was the postal-stage for runners, and that for mounted men or for horses, as well as the stage that consisted of a day's march or a journey. The latter stathm was probably a journey, while the former seems to have been a postal distance, corre-

sponding to the Teutonic post-meil of about two leagues. In India there was in ancient times a yojana of 4 ancient kos, which may have been from 5 to 6 miles, and was probably a postal-stage of the same type, though nominally a journey. The values of the various primary post-meil and gross-meil are given in the table.

THE JOURNEY, day's walk, or day's march, is now an obsolete itinerary measure in Europe, and nearly so elsewhere. The Norwegian and Westphalian postal-meil, and Swedish and the old Hanoverian polizei-meil, the longest of their type, do not exceed 7 English miles in length, and are therefore merely stages. In Asia, the journey was in many countries a specified measure, of which the various corresponding miles, leagues, and stages were well-defined submultiples.

The present tsan of China is = 1 pôu = 80 li.

The ancient marhala of Arabia = 8 parasangs.

The South-Indian kâdam = 7 nali-vali.

The gavada or journey in Maisur had two values, the ordinary and the large gavada, one about 10 miles, the other about $12\frac{1}{2}$ miles; and in India generally, to the present day, stages or camping-grounds are fixed at distances on a route, called a kuṅch or march, that are about 10 miles; while the dūna kuṅch, or double march of 20 miles, is similarly recognised. There are probably in several other countries accepted notions of the journey as a unit of measure that have not received the attention of metrologists.

GEOGRAPHICAL AND NAUTICAL ITINERARY MEASURES.

Measures of this type differ from all the preceding itinerary measures in that, instead of being multiples of

common and commercial linear measures, they are sub-multiples of some estimated geodetic quantity or value, such as the polar or the equatorial axis of a mean terrestrial sphere, a terrestrial meridional quadrant passing through some country or town, a mean degree of latitude, or of longitude, either on the earth as a sphere, as a spheroid, or on any great circle of the earth.

The geographical mile is considered in England to have a value that varies with the latitude; adopting the English method of treating the geographical mile as a minute of latitude, or a sixtieth of a degree, its value for any locality would have to be deduced from the nearest recorded or estimated values, such as the following:—

Latitude.	Value of the mile. Feet.
At 0°	6045·5
„ 10°	6044·4
„ 20°	6054·3
„ 45°	6075·7
„ 50°	6082·5
„ 54°	6085·1

But the more usual Continental method, as far as the books of foreign metrologists indicate, apparently was to treat the geographical mile as a sixtieth of a fixed value of a mean degree of latitude, determined or deduced from such measurements as have been afforded by various geodetic surveys. The value they use for their purpose is equal to 6076·98 English feet (at the scientific value); according to another computation, taking 111·134 mètres as = 121·540 yards, the value would be 6077·00 feet. On referring to the latest English book on the subject of 'The Science of Weighing and

Measuring and Standards of Measure and Weight,' by H. W. Chisholm, Warden of the Standards (London, 1877), the mean length of a degree of the meridian is stated to be 364591 English feet, at page 26 of that book; thus making the minute 6076·52 English feet. Taking the old accepted mean diameter of a sphere corresponding to the spheroid to be 7912·5 statute miles, a minute of mean latitude becomes 6076·36 English feet; but the higher value of 7916·7 miles gives 6076·52.

This variation in the estimated value of a mean minute of latitude amounts as a maximum to about $\frac{3}{4}$ of a foot, or one per myriad; if this were a final maximum, it might not be considered excessive, but future geodetic measurement and astronomical observation, aided by modern devices, such as electric communication, and electric-light signals, may cause perpetual alteration of the estimated value. The insufficient information now available, based on limited geodetic measurements, is at present fatal to accuracy and certainty. The recent triangulation across the Straits of Gibraltar, aided by the electric light, has enabled a connection to be formed between European and future African series; but until a few degrees both of latitude and longitude at and on the equator have been actually measured, not only by persons of some single nationality having particular metrologic views and objects, but by scientific men of several nations, the nucleus of geodetic measurement may be considered a mere embryo. At present the world is believed to be a doubly oblate spheroid, oblate at the poles, and oblate on the equator at 105° 34′ of longitude; future measurements may prove so much variety of configuration as to greatly alter the mode of reduction to mean sphere, and thus doubly affect the variation in value of the mean minute of latitude.

Under these prospects it is perhaps better not to attempt any fresh reduction of Continental geographical or of nautical miles to commercial or scientific measures of length, but to leave them in their original form, as submultiples of a mean degree of latitude, whatever it may be.

The geographical mile of Prussia and of Poland is an arc of 4 minutes, or 15 miles to the mean degree ; a larger mile of 5 minutes, or 12 miles to the mean degree is also adopted in Germany as well as in Bohemia ; a geographical mile of six minutes, or 10 miles to the degree, is adopted in Norway. The geographical leagues of France in former times were the common league of an arc of 2′ 24″, or 25 leagues to the mean degree, and the mean league of an arc of 2′ 42″, or $22\frac{2}{9}$ leagues to the mean degree.

The Italian mile is a geographical mile of 1 minute, or 60 miles to the mean degree. According to English notions, as before explained, none of these would be geographical miles.

Nautical miles and leagues may be estimated in several ways ; first, as an English geographical mile, or length of a minute of a degree of latitude at mean sea-level, varying with the latitude from 6046 feet to 6107 feet ; second, as a Continental geographical mile, of one minute of a mean degree of latitude, or about 6076·5 feet or 1·1508 statute mile ; third, as the value of a minute of a supposed mean degree of longitude at the equator, or about 6086·5 feet, or 1·1528 statute miles. The Continental nautical miles are determined by the second method. Besides the nautical miles thus determined, there are arbitrary knots or sea-miles in common use : first, the common knot of 6082·66 feet or

1·15202 statute miles; second, the Admiralty knot of 6080 feet or 1·1515 statute miles. The sea-league is equivalent to three sea-miles or knots as the case may be; and the sea-miles and knots are subdivided into 10 cables or 10000 fathoms, such cables and fathoms being termed nautical cables and nautical fathoms, to distinguish them from the common or land units.

COMMERCIAL AND SCIENTIFIC VALUES.

The English equivalents of the foreign metrical units of length, given in the following table, are arranged separately as commercial and scientific values. The whole series of commercial measures is by law determined at the English normal temperature of 62° Fahrenheit in air under special average conditions of pressure, air-density, latitude and so forth; this rather intricate arrangement affords the commercial man practically possible conditions under which he may compare his units with standards, and arrive at a close approximation to exactitude in any single detached unit. It hence meets the requirements of separate branches of commerce, and fulfils its object; although for scientific and for more extended purposes it fails, in that the relation between units of weight and volume is complicated.

The whole series of English scientific values of units of measure is determined at 32° Fahrenheit in vacuo; though the water used for comparison of weight and volume is at its maximum density, involving a temperature of about 39°. The relation between units of weight and volume is hence more simple; and the system is more suited to technical and scientific purposes. The decimalised series of scientific units, based solely on the

foot, square foot, cubic foot, and foot-weight render comparison with French units excessively simple throughout. The comparison of English scientific units with English commercial units of length is effected by allowing for the linear expansion of brass or bronze for 30° difference of temperature, about 0·000285, which can be easily applied in the form of a percentage; this small quantity seriously affects values in large units.

The French metric units are determined at 32° and 39° in the same way, and constitute a scientific system; no special arrangement to suit commercial purposes forming part of the system.

In comparing units belonging to systems of different temperature, contraction or expansion, has necessarily to be taken into account; this allowance has been made in the following tables.

IMPERIAL AND NATIONAL FEET.

	English Commercial Equivalent. Feet	English Scientific Equivalent. Feet	French Scientific Equivalent. Millimètres
Foot of Great Britain, America, Russia, and of their dependencies and colonies, at the normal temperature of 62° Fahr.	1·0000	0·9997	304·71
The same at the temperature of 32° Fahr.	1·0003	1·0000	304·79
Rheinfuss of Norway,[1] Denmark,[1] and Prussia	1·0300	1·0297	313·85
Foot of Sweden[1] and Finland[1] . .	0·9743	0·9740	296·87
Foot of the Austro-Hungarian Empire .	1·0373	1·0370	316·08
Spanish foot	0·9134	0·9132	278·33
Portuguese foot	1·0830	1·0827	330·00
Chinese foot of the Board of Works, Kambuchih	1·0594	1·0591	322·81

FORMER AND LOCAL SPECIAL FEET.

GERMANY:—			
Rheinfuss, Prussia	1·0300	1·0297	313·85
Anspach, Baireuth[1]	0·9839	0·9836	299·80
Altona, Hamburg[1]	0·9402	0·9399	286·5
Baden (metric foot)[1]	0·9846	0·9843	300
Bavaria (ordinary foot)	0·9578	0·9576	291·86
,, (Werkschuh)[1]	0·9721	0·9718	296·2
Culm[1]	0·9455	0·9452	288·1
Bavaria, Rhenish	1·0939	1·0936	333·33
Bremen[1]	0·9491	0·9488	289·2
Brunswick[1]	0·9365	0·9362	285·36
Cöln and Aschaffenberg[1]	c·9438	0·9435	287·6
Danzig[1]	0·9416	0·9413	286·9
Elsass (Stadtschuh)	0·9491	0·0488	289·2
,, (Landschuh)	0·9681	0·9678	295
Gotha	0·9439	0·9436	287·62
Halle[1]	0·9472	0·9469	288·63
Hanover[1]	0·9586	0·9583	292·10
Heiligenstadt and Erfurt[1]	0·9291	0·9288	283·1
Hesse Darmstadt[1]	0·8205	0·8203	250
Hesse (Electoral) ordinary[1] . . .	0·9442	0·9439	287·7
,, ,, (Landfuss) . . .	0·9350	0·9347	284·9
,, ,, (decimal Landfuss) .	1·3091	1·3087	398·9
Holstein[1]	0·9795	0·9792	298·45

[1] The ells of these countries and places were = 2 local feet; the stab = 2 ells.

FEET—*continued.*	English Commercial Equivalent. Feet	English Scientific Equivalent. Feet	French Scientific Equivalent. Millimètres
GERMANY :—			
Lippe Detmold[1]	0·9501	0·9498	289·5
Lothringen	0·9385	0·9382	285·93
Lübeck[1] and Rostock[1]	0·9448	0·9445	287·9
Münster[1]	0·9544	0·9541	290.8
Mecklenburg Strelitz and Schwerin[1]	0·9550	0·9547	291
Nassau (Werkfuss)	0·9846	0·9843	300
,, (Landfuss)	1·6409	1·6404	500
Nuremberg (Stadtfuss)	0·9972	0·9969	303·86
,, (Artilleriefuss)	0·9261	0·9258	293·15
Oldenburg	0·9727	0·9725	296·4
Saxe Weimar (Werkfuss)[1]	0·9255	0·9252	282
,, (Landfuss)	1·4808	1·4804	451·2
Saxony { Dresden[1]	0·9291	0·9288	283·1
Saxony { Leipzig[1]	0·9276	0·9274	282·66
Silesia (Prussian)[1]	0·9450	0·9447	287·96
Würtemberg	0·9402	0·9399	286·5
Worbis[1]	0·9402	0·9399	286·5
SWITZERLAND :—			
Berne and Freiberg	0·9624	0·9621	293·26
Basel	0·9995	0·9992	304·54
Saint Gall[1]	1·0093	1·0090	307·54
Geneva	1·6012	1·6007	487·94
Glaris,[1] Grisons, Uri,[1] Waadt,[1] Valais,[1] Schweitz[1]	0·9846	0·9843	300
Lucerne,[1] ordinary foot	1·0300	1·0297	313·85
,, Joiners' foot	0·9972	0·9969	303·86
,, Land and Works	0·9328	0·9325	284·23
Neufchâtel, Landfuss	0·9624	0·9621	293·26
,, Feldmessfuss	0·9424	0·9421	287·15
Rheinfelden, Vienna foot	1·0373	1·0370	316·08
Schaffhaus,[1] Werkschuh	0·9776	0·9773	297·88
Ticino, Brazetto of artisans	1·3029	1·3025	397
Zug[1] (ordinary foot)	0·9846	0·9843	300
,, (Steinschuh)	0·8818	0·8815	268·7
Zurich[1] (ordinary foot)	0·9846	0·9843	300
,, (Steinschuh)	0·9891	0·9888	301·38
FRANCE :—			
Former pied de roi ou de Paris, duod.	1·0661	1·0658	324·84
Pied métrique (from 1812 to 1840), duod.	1·0939	1·0936	333·33
NETHERLANDS :—			
Old Amsterdam voet, undec.	0·9291	0·9288	283·1
Old Brussels ,, ,,	0·9050	0·9047	275·75

[1] The ells at these places were = 2 local feet; and the stab = 2 ells.

FEET—*continued.*	English Commercial Equivalent. Feet	English Scientific Equivalent. Feet	French Scientific Equivalent. Millimètres
AUSTRIA :—			
Imperial foot	1·0373	1·0370	316·08
Bohemia [1]	0·9727	0·9724	296·4
Galicia [1]	0·9746	0·9743	296·96
Illyria, Trieste	1·0439	1·0436	318·07
Moravia	0·9714	0·9711	296
Poland (Cracow stopa) [1]	1·1696	1·1692	356·4
Silesia [1]	0·9498	0·9495	289·42
Tyrol	1·0965	1·0962	334·10
RUSSIA :—			
Imperial foot	1·0000	0·9997	304·71
Lithuania [1]	1·0661	1·0658	324·84
Revel [1]	0·8728	0·8725	265·96
Riga [1]	0·8995	0·8992	274·08
Poland (Warsaw stopa) [1] after 1819	0·9452	0·9449	288
Pernau [1]	0·9002	0·8999	274·3
ITALY :—			
Bergamo [2]	1·4368	1·4364	437·8
Bologna ($\frac{1}{10}$ pertica)	1·2474	1·2470	380·1
Brescia [2]	1·5457	1·5452	471
Cremona [2]	1·5868	1·5863	483·5
Mantua	1·5323	1·5318	466·86
Milan (agrarian foot) [2]	1·4283	1·4279	435·2
Modena [2]	1·7166	1·7161	523·05
Padua [2]	1·1729	1·1725	357·4
Parma (agrarian foot)	1·7875	1·7870	544·67
Piacenza [2]	1·6307	1·6302	469·9
Piedmont (piede liprando) [2]	1·6861	1·6856	513·77
,, (piede manuale)	1·1241	1·1238	342·51
Reggio [2]	1·7423	1·7418	530·9
Rome	0·9776	0·9773	297·9
Savoy (Chambéri)	1·1139	1·1136	339·4
Venezia [2]	1·1412	1·1409	347·74
Verona [2]	1·1253	1·1250	342·9
Vicenza [2]	1·1729	1·1726	357·4
SPAIN :—			
Castile	0·9134	0·9132	278·33
Valencia	9·9922	0·9919	302·33
Aragon	0·8434	0·8431	257
AMERICA :—			
Mexico, Peru, Chili, La Plata, La Havana (old Spanish foot)	0·9271	0·9268	282·5
Pernambuco	0·9975	0·9972	303·94
Quebec (pied du roi)	1·0651	1·0658	324·84

[1] The ells at these places were = 2 local feet; and the stab = 2 ells.
[2] The fathoms (cavezzi or trabucchi) of these places were = 6 local feet.

FEET—*continued.*	English Commercial Equivalent. Feet	English Scientific Equivalent. Feet	French Scientific Equivalent. Millimètres
INDIA :—			
Malabar ady	0·8717	0·8714	265·60
CHINA :—			
Kambuchih, or kongpuchih of the Board of Works	1·0594	1·0591	322·81
Chih of the Imperial Survey (1700)	1·0083	1·0080	307·24
Chih of the Tsing dynasty since 1644	1·0487	1·0484	319·54

LOCAL VALUES.

Canton customs chih, of the British treaty	1·1750	1·1747	358·03
,, retail merchants' chih	1·2133	1·2130	369·70
,, wholesale merchants' chih	1·2270	1·2267	373·88
,, architects' chih	1·0583	1·0580	322·47
,, tailors' chih	1·2238	1·2235	372·90
Pekin, Palace chih for works	1·0390	1·0387	316·59
,, Imperial statistics chih	1·0333	1·0330	314·85
,, Tribunal of Mathematics chih	1·0932	1·0929	333·11
,, Board of Works chih (doubtful value)	1·0283	1·0280	313·33
,, ordinary chih	1·0567	1·0564	321·98
,, land chih	1·0729	1·0726	326·92
,, architects' chih	1·0487	1·0484	319·55
,, tailors' chih	1·1013	1·1010	335·58
,, mercers' chih	1·1217	1·1214	341·79
Nankin commercial chih	1·1614	1·1611	353·89
Shanghai land-revenue chih	1·0984	1·0981	334·69
,, custom-house chih	1·1740	1·1737	357·73
,, ship-builders' chih	1·3083	1·3080	398·65
,, artisans' chih	1·0474	1·0471	319·15
,, carpenters' chih	0·9284	0·9281	282·89
,, tailors' chih	1·1600	1·1597	353·46
Amoy ordinary chih	1·0083	1·0080	307·24
,, custom-house chih	0·9860	0·9857	300·44
,, traders' chih for fabrics	1·0200	1·0197	310·80
Macao customs chih	1·2155	1·2152	370·37
,, wholesale merchants' chih	1·2220	1·2217	372·35
,, retail merchants' chih	1·2000	1·1997	365·65
,, artisans' chih	1·1300	1·1297	344·32
Tientsin tradesmen's chih	1·1417	1·1414	347·89
,, ordinary chih	1·0300	1·0297	313·85

The chih = 10 tsun = 100 fan almost invariably.

JAPAN :—			
Ordinary shaku or jaku = 10 sung = 100 bu[1]	0·9909	0·9906	301·94
Kujirad shaku for fabrics	1·2500	1·2497	380·89

[1] This is the latest correct value obtained in 1881.

FEET—*continued.*	English Commercial Equivalent. Feet	English Scientific Equivalent. Feet	French Scientific Equivalent. Millimètres
MANILA :—			
The Castilian pié. See General Values.			
A Chinese chih for ship-building &c.	1·1515	1·1512	350·87

CUBITS, ELLS, BRACCI, ETC.

England, North America, and India cubit	1·5000	1·4995	457·10
DENMARK, NORWAY, AND SWEDEN:—			
Swedish aln	1·9486	1·9480	593·74
Danish ell = 2 feet	2·0600	2·0594	627·71
Iceland ale	1·8731	1·8725	570·7
GERMANY. The German ells were very often 2 local feet; see Table of Feet. Those that did not consist of two local feet were the following :—			
Anhalt elle	2·0869	2·0863	635·9
Bavaria (34¼ zoll)	2·7338	2·7330	833·01
Berlin, Prussian (25½ zoll)	2·1887	2·1880	666·9
Coblentz	1·8812	1·8807	573·2
Coburg	1·9242	1·9236	586·3
Frankfurt, Homburg	1·7962	1·7957	547·3
Gotha, Saxe Gotha	1·8465	1·8460	562·65
Hof, Bavaria	2·0914	2·0908	637·3
Mannheim, Baden	1·8316	1·8311	558·1
Nassau	1·8230	1·8225	555·5
Oldenburg	1·8969	1·8964	578
Würtemberg	2·0159	2·0153	614·25
SWITZERLAND :—			
Altorf elle	2·3024	2·3017	701·6
Berne	1·7805	1·7800	542·5
Basel (elle or braccio)	1·7722	1·7717	540
Langenthal	2·0452	2·0446	623·2
Neufchâtel (elle or halberstab)	1·8233	1·8227	555·55
Rheinfelden (Argau)	1·7985	1·7980	548
Uznach	2·0211	2·0205	615·85
AUSTRIA :—			
Austro-Hungarian Imperial elle	2·5518	2·5511	777·6
Hungary (Kaschau)	1·9804	1·9798	603·4
,, Buda-Pesth	1·8831	1·8826	573·8
Cracow lokiec = 4 cwierci	2·0249	2·0243	617
Transylvania (Clausenberg)	2·0458	2·0452	623·4
Moravia	2·5949	2·5941	790·7
Tyrol (generally)	2·6393	2·6385	804·2
,, (Inspruck)	2·5801	2·5793	786·2
,, (Trent, for wool)	2·2210	2·2203	676·75
,, (,, for silk)	2·0085	2·0079	612

CUBITS—*continued.*	English Commercial Equivalent. Feet	English Scientific Equivalent. Feet	French Scientific Equivalent. Millimètres
AUSTRIA :—			
Illyria (Trieste, for wool)	2·2210	2·2203	676·75
,, (,, for silk)	2·1069	2·1063	642
NETHERLANDS :—			
Amsterdam el (= 16 talien)	2·2572	2·2566	687·8
Brussels el ,,	2·2830	2·2823	695·64
ITALIAN BRACCI, formerly in general use :—			
Ancona	2·1791	2·1785	664
Bergamo	2·1506	2·1500	655·3
Bologna (and for silk at Brescia)	2·1003	2·0997	640
Brescia (for woollen fabrics)	2·2119	2·2113	674
Carrara (commercial braccio)	2·0338	2·0332	619·7
Casale	2·1706	2·1700	661·4
Cremona	1·9524	1·9518	594·9
Firenze and Livorno ($\frac{1}{5}$ pertica = 2 palmi [1] = 20 soldi ; and Pisa, braccio di panno, $\frac{1}{5}$ pertica = 12 crazie)	1·9153	1·9147	583·6
Forli	2·0198	2·0183	615·2
Genoa (= $2\frac{1}{3}$ palmi)	1·9077	1·9071	581·25
Lucca (for silk)	1·9462	1·9456	593
,, (for woollen)	1·9855	1·9849	605
Mantua	2·1129	2·1123	643·8
Milano (= 12 oncie) before 1803	1·9523	1·9517	594·9
Modena	2·0774	2·0768	633
Napoli (= $2\frac{2}{3}$ palmi,[1] spans)	2·2930	2·2923	698·7
Novara	1·9715	1·9709	600·7
Padua (for silk)	2·0922	2·0916	637·5
,, (for woollens)	2·2350	2·2343	681
Parma (di legno, foot, and $\frac{1}{6}$ pertica)	1·7792	1·7787	542·15
,, (for silk)	1·9214	1·9208	588
,, (for cloth)	2·1003	2·0997	640
Pavia	1·9523	1·9517	594·9
Perugia	2·1218	2·1212	646·5
Piacenza	2·2153	2·2146	675
Reggio (braccio = 12 oncie)	2·1037	2·1031	641
Ravenna	2·2063	2·2056	672·25
Rimini	2·1010	2·1004	640·2
Rome (3 p. for woven goods)	2·0872	2·0866	636
,, (4 p. ordinary commerce)	2·7831	2·7823	848
,, (6 p. sacri,) braccio di ara	2·4614	2·4607	750
Siena (for woollen goods)	1·2393	1·2389	377·6
,, (for linen ,,)	1·9700	1·9694	600·3
Sinigaglia (for silk and cloth)	2·1791	2·1785	664
,, (for local cloth	2·5665	2·5657	782
Trevico	2·2010	2·2003	670·7
Trevisa (for silk)	2·0807	2·0801	634

[1] These palmi were substitutes for feet

CUBITS—*continued.*	English Commercial Equivalent. Feet	English Scientific Equivalent. Feet	French Scientific Equivalent. Millimètres
ITALIAN BRACCI :—			
Trevisa (for woollen)	2·2186	2·2179	676
Udine (for silk)	2·0872	2·0866	636
,, (for woollen)	2·2349	2·2342	681
Urbino	2·2950	2·2943	699·3
Venezia (for silk)	2·0961	2·0955	638·7
Venezia (for woollen)	2·2429	2·2422	683·4
Verona (for silk)	2·1081	2·1075	642·4
,, (for woollen)	2·1299	2·1293	649
Vicenza (for silk)	2·0922	2·0916	637·5
,, (for woollen)	2·2655	2·2648	690·3
SWISS AND TYROLEAN BRACCI :—			
Basel	1·7722	1·7717	540
Bolzano	1·8042	1·8037	549·75
Lugano (piccolo)	1·7271	1·7266	526·3
,, (lungo)	2·2277	2·2270	678·8
Locarno (for silk)	1·5748	1·5743	479·8
,, (the ordinary)	1·9693	1·9687	600·05
Roveredo (for silk)	2·1102	2·1096	643
,, (for woollen)	2·2940	2·2933	699
Ticino (for silk)	1·7271	1·7266	526·3
Ticino (the ordinary)	2·2277	2·2270	678·8
Trent (for silk)	2·0709	2·0703	631
,, (for cloth)	2·3039	2·3032	702
Unterwalden	1·8719	1·8716	570·45
Wintherthur and Zoffingen	1·9938	1·9932	607·5
Zoffingen (retail)	2·0478	2·0472	624
BRACCI OF THE IONIAN ISLANDS :—			
Cephalonia, Cerigo, Corfu, Thiaki, Paxos, Santa Maura, and Zante (for silk)	2·1151	2·1145	644·5
Cephalonia, Cerigo, Corfu, Thiaki, Paxos, Santa Maura, and Zante (for cotton and woollen)	2·2662	2·2655	690·5
SPAIN, PORTUGAL, AND BRAZIL :—			
Codo = ½ vara = 1½ pie	1·3701	1·3698	417·5
Codo de ribera = 2 pies	1·8269	1·8264	556·67
Lisbon covado = 24 inches	2·1660	2·1654	660
,, commercial, 24¾ inches	2·2338	2·2331	680·6
Oporto covado	2·1796	2·1789	664·1
Goa covado	2·2333	2·2326	680·4
Brazilian covado = 25¾ inches	2·1397	2·1391	652·2
,, commercial covado	2·2219	2·2212	677
RUSSIA :—			
Arsheen = 16 vershok	2·333$\dot{3}$	2·3327	711
Ancient arsheen = 32 palez	2·3564	2·3557	718
Crimean pik	3·1983	3·1973	974·5
Crimean halebi, or arsheen	2·3987	2·3980	730·9
Old Warsaw lokiec[1]	1·9543	1·9538	595·5

[1] The lokiec of 1819 was = 2 stopa.

CUBITS—*continued.*	English Commercial Equivalent. Feet	English Scientific Equivalent. Feet	French Scientific Equivalent. Millimètres
ROUMANIA :—			
Bucharest halibin	2·3015	2·3008	701·3
,, endézah	2·1736	2·1730	662·3
TURKISH AND GREEK PIKS :—			
Stambul pik halebi, or arsheen (silks and woollens)	2·3257	2·3250	708·65
Stambul draa, or pik endézah (cottons and carpets)	2·2556	2·2550	687·3
Stambul, common pik, Mekka standard = 24 kirāt	2·2500	2·2494	685·6
Scutari pik	2·0720	2·0714	631·36
Albania, Valona pik	2·0541	2·0535	625·9
,, Arta pik	1·8722	1·8716	570·45
,, Negropont pik	2·0226	2·0220	616·3
Morea, Mistra pik	1·4998	1·5003	457·26
,, Patras pik (for woollens)	2·2514	2·2507	686
,, ,, (for silk)	2·0848	2·0842	635·24
Lepanto pik	2·0866	2·0860	535·8
Negropont	2·0226	2·0220	616·3
Candia	2·0914	2·0908	637·3
Chios (large pik)	2·2514	2·2507	686·0
,, (small pik)	2·1669	2·1663	660·3
Cyprus pik	2·2039	2·2033	671·56
Rhodes pik	2·4808	2·4801	755·93
SYRIA :—			
Acra pik	2·2750	2·2743	693·2
Aleppo and Alexandretta pik	2·2222	2·2215	677·1
Damascus (large pik)	2·0744	2·0736	632·1
,, (small pik)	1·9101	1·9095	582
Jerusalem pik	2·2514	2·2507	686
Sidon pik	1·9841	1·9835	604·56
Smyrna pik	2·2500	2·2493	685·6
Tripoli pik	2·2506	2·2499	685·8
ARABIAN PIKS :—			
Mesopotamia, Bassara, an Aleppo pik	2·2083	2·2076	642·3
Mesopotamia, Bassara hadid (for cotton and linen)	2·8500	2·8492	868·4
Arabia, Moka pik	1·5830	1·5825	482·4
,, Mekka pik = 24 kirāt	2·2500	2·2494	685·6
,, Beyt al fakiah pik	1·5000	1·4995	457·1
EGYPTIAN PIKS :—			
Alexandrian pik endazi (for cotton)	2·0692	2·0686	630·5
,, ,, beledi (for linen)	1·8379	1·8373	560
,, ,, Stambul (for cloth)	2·2194	2·2187	676·3
Rosetta pik	1·8752	1·8746	571·35
Cairo pik endazi (for Oriental silks)	2 0951	2·0945	638·4

CUBITS—*continued.*	English Commercial Equivalent. Feet	English Scientific Equivalent. Feet	French Scientific Equivalent. Millimètres
EGYPTIAN PIKS :—			
Cairo pik beledi (for cloth and cotton	1·8657	1·8651	568·47
Cairo pik Stambul (for European silks)	2·2690	2·2684	691·4
Cairo pik méhandeze (for land) = 24 kirāt	2·5320	2·5312	771·5
Abyssinia, a Turkish pik	2·2506	2·2499	685·8
ALGERIAN, BERBER, AND MOORISH PIKS :—			
Algeria, the Turkish pik = 8 robi	2·1003	2·0997	640
,, the Moorish or Arab pik	1·5753	1·5748	480
,, Oran pik	2·2514	2·2507	686
Tunis pik (for woollen fabrics)	2·2084	2·2077	672·91
,, ,, (for silken ,,)	2·0699	2·0693	630·73
,, ,, (for linen ,,)	1·5525	1·5520	473·05
Morocco covado	1·7500	1·7495	533·2
Also a Moorish pik	2·1692	2·1685	660·96
Barbary, Tripoli pik = 3 spans	2·2024	2·2017	671·05
,, arbidraa or small pik	1·5863	1·5858	483·35
PERSIAN PIKS :—			
Bandar Abbas pik	2·001	2·001	609·75
Bushahr gezcha	1·533	1·533	467·1
INDIAN HĀTH :—			
Common hāth = ½ gaz = 2 spans	1·500	1·500	457·1
Ahmadnaggar hāth = 4/7 gaz	1·125	1·125	342·8
Belgaum hāth	1·604	1·604	488·75
Bangalur hāth = ½ gaz = 8 gira	1·592	1·592	485·1
Dharwar hāth	1·625	1·625	495·15
Jaulna hāth = 24 unglī = 8 gira	1·400	1·400	426·6
Masulipatam hāth = 3 spans	1·594	1·594	485·7
Ranibednor hāth	1·573	1·573	479·3
Surat hāth = 18 tassu	1·742	1·742	530·8
Bombay hāth = 16 tassu	1·500	1·500	457·1
Goa covado	2·233	2·233	680·4
Ceylon cobido	1·542	1·542	469·9
Burma, ordinary cubit = 18 pulghat	1·500	1·500	457·1
,, royal saundung = 22 pulghat	1·833	1·833	558·6
CUBITS OF EASTERN ASIA :—			
Singapore (asta); Prince of Wales' Island (asta = ¼ depa); Sumatra, Fort Marlborough (esto = ¼ depoh)	1·500	1·500	457·06
Sumatra, common etto	1·560	1·560	475·3
Thaï (Siam) sok = 2 kub = 12 niu	1·666	1·666	507·8
China—Canton, Cachao, Pekin, Sulu Islands (cubit = 10 fun)	1·219	1·219	371·4
Moluccas, Amboyna, Malacca (cubit)	1·522	1·522	463·8
Java, Bantam (cubit)	1·650	1·650	502·8
,, Batavia ,,	2·250	2·250	685·6
Anam thuok = 10 tak	1·600	1·600	487·53
Borneo hasta	1·500	1·500	457·06

DOUBLE-CUBITS.

Yard, mètre, vara, stab, aune, gaz, zar', &c.

GENERAL VALUES.	English Commercial Equivalent. Yards	English Scientific Equivalent. Feet	French Scientific Equivalent. Mètres
England, North America, and India : the yard = 2 cubits = 3 feet = 16 nails ; or gaz = 2 hath = 16 gira	1	2·9991	0·9141
The scientific value of the same at 32° .	1·0003	3	0·9144
Germany, Austria, and Switzerland : the stab = 2 local ells. See tables of ells.			
France, Italy, &c. : the mètre, or metro. Holland and Belgium : the Nederlandsche el or mètre	1·0939	3·2809	1
Spain : the Castilian vara = 2 codos ordinarios = 3 piés	0·9134	2·7396	0·8350
Portugal : the Lisbon vara = $1\frac{2}{3}$ covados = $3\frac{1}{3}$ pés	1·2033	3·6090	1·1000
Persia : zar' = 4 charak = 16 gira . .	1·1377	3·4121	1·0400
Thai (Siam) : ken = 2 sok = 4 küb . .	1·1111	3·3324	1·0157
Sumatra : hailah = 2 esto = 4 jankal . . Borneo ella = 2 hasta	1	2·9991	0·9141

LOCAL OR FORMER SPECIAL VALUES.

French aune (mes. anc.)	1·3001	3·8992	1·1884
,, demitoise (mesures anc.) . .	1·0660	3·1973	0·9745
,, aune métrique (1812–1837) . . Stab of Waadt, Valais, and Rhenish Bavaria (metric)	1·3127	3·9704	1·2000
French demitoise métrique (1812–1837) .	1·0939	3·2809	1
Vara of Aragon = 4 quartas o palmos .	0·8434	2·5296	0·7710
,, Barcelona = 4 palmos = 16 quartos	0·8490	2·5460	0·7760
,, Galicia	1·1874	3·5614	1·0855
,, Valencia = 4 palmos . . .	0·9921	2·9757	0·9070
,, Canary I.	0·9206	2·7609	0 8415
,, Cuba, Mexico, and La Plata .	0·9277	2·7822	0·8480
,, Chili, Peru, and Manila . .	0·9272	2·7806	0·8475
,, Curaçao	0·9274	2·7813	0·8477
,, Brazil	1·1892	3·5663	1·0870
,, Madeira I.	1·2005	3·6000	1·0973

Double-Cubits—continued.

ORIENTAL UNITS.	English Commercial Equivalent. Yards	English Scientific Equivalent. Feet	French Scientific Equivalent. Mètres
ARABIA :—			
Gaz of Mokha and Betel faghi	0·6943	2·0823	0·6347
(An exceptional gaz that was probably a royal cubit.)			
MESOPOTAMIA :—			
Gaz of Baghdad	0·8797	2·6382	0·8041
Hadid of Bassara	0·9500	2·8819	0·8784
PERSIA :—			
General value of zar' = 2 kadam (step)	1·1377	3·4121	1·0400
Zar' of Yazd and Kirman	1·0666	3·1989	0·9750
Common geza	0·6893	2·0674	0·6301
Royal geza	1·0340	3·1011	0·9452
Common arish	1·0636	3·1899	0·9723
Royal arish	0·8761	2·6274	0·8008
Isfahan geza	1·0401	3·1194	0·9508
Bandarabbas geza	1·0756	3·2259	0·9832
Bandarabbas double cubit	1·0503	3·1500	0·9601

SOUTH-INDIAN LOCAL UNITS.

The Imperial gaz or yard	1	2·9991	0·9141
Ahmadnaggar gaz = $1\frac{3}{4}$ hath	0·6806	2·0412	0·6222
Bangalur gaz = 2 hath	1·0611	3·1824	0·9700
Baroda gaz = 24 tassu	0·7535	2·2599	0·6888
Belgaum gaz = 24 tassu	0·9132	2·7387	0·8348
Bombay gaz = $1\frac{1}{2}$ hath	0·7500	2·2494	0·6856
Calicut gaz	0·7889	2·3661	0·7211
Cambai gaz	0·7777	2·3325	0·7109
Dharwar gaz	0·9042	2·7117	0·8265
Haidarabad (dakhan) gaz	0·9815	2·9436	0·8972
Jaulna (dakhan) gaz = 2 hath	0·9333	2·7990	0·8531
Malwa gaz	0·7777	2·3325	0·7109
Masulipatam gaz = 2 hath	1·0625	3·1866	0·9713
Palamkattah gaz	1·0069	3·0198	0·9204
Seringapatam gujah	1·0694	3·2073	0·9776
Surat cloth gaz = 24 tassu	0·7685	2·3049	0·7025
,, artisans' gaz of 24 tassu	0·6666	1·9992	0·6094
,, woodwork gaz = 20 wassa	0·7246	2·2632	0·6898

EASTERN ASIA :—

See General Values.

THE PACE, OR DOUBLE STEP.

GENERAL VALUES.	English Commercial Equivalent. Pace	English Scientific Equivalent. Feet	French Scientific Equivalent. Mètres
Pace of England and America = 5 feet .	1	4·9986	1·52350
The scientific value of the same at 32° Fahr.	1·0003	5	1·52395
Ordinary schritt, pace of Germany = 5 Rheinfuss	1·0300	5·1486	1·56925
Geodetic schritt, pace of Germany = 5·9016 Rheinfuss	1·2157	6·0770	1·85223
Ancienne mesure, pas of France = 5 pieds du roi	1·0661	5·3289	1·62420
Paso of Spain = 5 pié	0·9134	4·5659	1·39167
Passo of Portugal = 5 pé	1·0830	5·4135	1·6500
Switzerland, pace of 5 Bernese feet . .	0·9624	4·8108	1·46628
Arab kathuah of 6 old feet = ½ gassab .	1·2602	6·2993	1·9200
Chinese pu[1] or pace = 5 chih . . .	1·0594	5·2955	1·61405
Japanese ink or tattamy	1·2472	6·2337	1·90000
Sumatra gochih or depah of 4 cubits .	1·2000	5·9983	1·82826

FORMER SPECIAL OR LOCAL PACES AND STEPS.

Hamburg, ordinary double step, 4·8 local feet	0·9026	5·5118	1·37516
,, geodetic pace, 6·535 local feet	1·2157	6·0770	1·85223
Berne, pas forestier 3 feet step . .	0·5794	2·8864	0·87977
,, pas agraire, 2½ feet step . .	0·4812	2·4054	0·73314
Trieste, passo = 5 feet	1·0439	5·2178	1·59036
ITALIAN PASSI :—			
Rome, 5 piede	0·9776	4·8869	1·48950
Tuscany, 3 bracci	1·1492	5·7442	1·75080
Napoli,[2] 7½ palmi before 1840 . . .	1·2898	6·4473	1·96511
,, geodetic pace (of 1840) = 7 palmi geodetichi	1·2157	6·0770	1·15223
Venezia, 5 piede	1·1401	5·7044	1·73868
Bologna, 5 piede	1·2474	6·2353	1·90050
Milanese pace	1·0847	5·4220	1·65260
French Antilles, pas agraire, 3½ feet step .	0·7463	3·7302	1·13694
Ionian Islands, 5 feet (Venetian) . .	1·1401	5·7044	1·73868
Patras pace, 5 feet (Parisian) . . .	1·0661	5·3288	1 62420

[1] The pu is also a fathom.
[2] The passo di Napoli is also a pertica.

FATHOMS.

GENERAL RATIOS.

England, Russia, and India	Fathom or Danda	= 2 gaz = 6 local feet
Russia	Sasheen	= 7 local feet
Germany, generally Austria, generally	Faden or klafter	= 6 local feet
Sweden Denmark Belgium Holland	Famn or toise	= 6 local feet
France, old measures	Toise Brasse marine	= 6 local feet = 5 local feet
Spain	Estado Braza, brazada	= 6 local feet = 6 local feet
Portugal	Braça for soundings Toesa or braça	= 5 local feet = 2 local varas
Italy generally	Cavezzo or trabucco	= 6 local feet
Switzerland	Klafter or toise also toise or perch	= 8 local feet = 10 local feet
China	Pu	= 5 local feet
Japan	Ikje	= nearly 7 English feet
Thai (Siam)	Wa	= 4 local cubits
Sumatra, Malacca, &c.	Depah	= 4 local cubits
Japan	Keng	= 6 local feet
Anam	Ngu	= 5 local cubits

LOCAL OR SPECIAL RATIOS.

Poland	Sazeen	= 6 local feet
Savoy	Tesa	= 6 local feet
Darmstadt	Klafter	= 10 local feet
Prussia	Lachter	= $6\frac{2}{3}$ local feet
Saxony	Lachter	= 7 local feet
Bohemia	Dumpflachter	= 4 Bohemian ells
Burgundy French provinces	Toise	= $7\frac{1}{2}$ local feet = $5\frac{1}{2}$ to 8 local feet, various
Canary Islands	Brazada	= $6\frac{1}{2}$ local feet
Florence and Mantua	Cavezzo	= 6 local bracci
Sardinia and Nice	Trabucco	= 12 local spans
Naples	Bracciata	= 5 French feet
Rome	Canna	= 8 palmi
Naples	,,	,,
Florence	,,	,,
Nice	,,	,,
Malta	,,	,,

AGRARIAN LINEAR MEASURES.

GENERAL RATIOS.

RODS.

Rods of 10 *local feet, or double paces.*

Austro-Hungary	Denmark	Lothringen	China
Baden	Norway	Würtemburg	Prussia
Bavaria	Frankfurt	Zurich	England (new
Darmstadt	Elsass	Basel and Berne	decimal series)

Rods of about 12 *local feet, or double fathoms.*

Prussia, Franconia, Würzberg, Anspach, Constance, Spain	12 feet or 2 fathoms	Arab gasab, 8 cubits		= 12 local feet
		Burmese dha, 7 royal cub.		= 12′ 10″ English
		Sumatra tunga, Malacca jamba	8 cubits	= 12′ English
		Guinea jaktan		= 12′ Eng. nearly
		Turkish gasab		= $5\frac{1}{2}$ arsheen

POLES, PERCHES, VERGES, &c.

Poles of 15 *local feet.*

Lithuania, Silesia, and Poland.

Poles of 16 *local feet.*

Aachen	Coblentz	Gotha	Nuremberg
Bremen, Hamburg	Cöln	Lippe-Detmold	Pomerania
Brunswick, Hanover	Creveld	Luxemburg	Weimar
	Dresden, Leipsig	Maintz	—
		Mecklenburg	Sweden

Other poles of various values.

Gotha, Hesse-Cassel — 14 local feet
England, $16\frac{1}{2}$ local feet
Ireland, 21 local feet
Scotland, fall of 6 ells or 18·53 feet
Oldenburg, Paris — 18 local feet
Normandy, 22 local feet
France, 20 to 22 local feet
Belgium, $16\frac{1}{3}$ to $20\frac{1}{3}$ local feet

Dutch roede, Metric French perche — 10 mètres
(Old) Amsterdam, 13 local feet
(Old) Brussels, $16\frac{1}{3}$ local feet
,, also verge, 20 local feet
Baden ruthe, Waadt — 3 mètres
Indian vansa, 10 local cubits
Malabar culey, 24 adye
Trichinopoly kolu, $21\frac{1}{6}$ feet English
Anam Sao, 15 cubits

CORDS.

Old English cord or rope	20 or 25 feet
Brittany and Poitiers corde	24 Parisian feet
Tours and other places in France	25 Parisian feet
Spain, cuerda = $8\frac{1}{4}$ varas	$24\frac{3}{4}$ Castilian feet

CHAINS.

England (Older)	Gunter's chain of 22 yards or 4 poles
,, (Newer)	Ramsden's chain of 100 feet or 10 rods (in the series of decimal measures)
Germany	generally chains of 10 rods, and mostly also of 100 local feet
Dantzig	seil of 150 local feet
Kœnigsberg	schnur of 150 local feet
Bohemia.	waldseil of 42 local ells
Bohemia.	weinbergseil, 64 local ells
Poland	snurow of 150 local feet
France, Holland, and Belgium	chaîne of 20 mètres, or double-décamètre
Valencia.	cuerda of 40 local varas
Naples	catena of 8 passi, also one of 10 passi
Arabia	chain of 10 gassab (rods) or 120 local feet
India	tenab of 50 gaz (yards)
Thai (Siam)	sen of 20 wa (fathoms) or 80 (local cubits) sok
China	yu or yin of 100 chih

ACRE-SIDES.

Austrian joch-side	= 40 klafter	= 240 local feet
Baden, morgen-side	= 20 ruthen	= 200 local feet
Bavarian tagwerk-side	= 20 ruthen	= 200 local feet
Darmstadt, morgen-side	= 20 klafter	= 200 local feet
England, cable (new series) or century-side	= 10 chains	= 1000 feet
France, hectare-side	= 5 chains	= 100 mètres
Mecklenberg, acre-side	= 10 ruthen	= 160 local feet
Piedmontese giornata-side	= 20 trabucchi	= 120 local feet
Tyrolese starland-side	= 10 perches	= 100 local feet
Spanish fanegada-side	= 96 varas	= 288 local feet
,, cuadra-side	= 150 varas	= 450 local feet
Arabian feddan-side	= 2 chains	= 240 local feet
Sumatra, linear orlong	= 80 hailah (yards)	= 160 cubits

A large number of countries possess rectangular land units of agrarian superficial measures, which do not afford an aliquot acre-side in feet, cubits, or yards.

ITINERARY MEASURES.

ORDINARY MILES, MILLIARIA, AND CORRESPONDING UNITS.

	English Commercial Equivalent. Miles	English Scientific Equivalent. Leagues	French Scientific Equivalent. Kilom.
English statute mile (since 1824) = 8 furlongs = 1760 yards = 1056 paces	1	0·5278	1·6089
The same, reduced to 32° Fahr.	1·0003	0·5280	1·6093
Old London mile = 1000 paces = 5000 feet	0·9470	0·4998	1·5236
The same, reduced to 32° Fahr.	0·9472	0·5000	1·5240
Irish mile = 2240 yards	1·2728	0·6718	2·0477
Scotch mile = 1984 yards = 1920 ells	1·1273	0·5951	1·8137
France, Italy, and the Netherlands, kilomètre = 1000 mètres	0·6216	0·3291	1
Old French mile = 1000 toises	1·2114	0·6395	1·9490
Russia, werst = 500 sasheen = 3500 feet	0·6629	0·3499	1·0665
Spanish milla = 1000 paces = 5000 feet	0·8650	0·4566	1·3917
Portuguese milha = ⅓ legoa = 6236·37 feet of 54 to a mean degree	1·2792	0·6752	2·0580
Old Italian units. (See Geographical miles.)			
Roman mile = 1000 paces = 5000 feet	0·9257	0·5430	1·4895
Milan mile = 1000 passi	1·0271	0·6024	1·6526
Venice mile = 1000 passi	1·0807	0·6839	1·7387
Naples mile = 1000 passi (before 1840)	1·1969	0·7020	1·9257
Tuscan mile = 2833⅓ bracci = 566⅔ pertiche	1·0278	0·5425	1·6535
Turkish berri	1·0361	0·5469	1·6670
Arab mile = 1000 kathuah or paces	1·1934	0·6299	1·9200
Indian kos = 2000 gaz or yards	1·1364	0·5998	1·8282
Chinese li = 360 paces = 1800 feet (B. Works). (See geodetic li)	0·3612	0·1906	0·5811

LEAGUES, STUNDEN, AND UER.

	Miles	Leagues	Kilom.
The old leagues of England, Spain, Portugal, the sea league of Holland, the Turkish agasha, the Arab farsakh or parasang, consisted of 3 miles	(See Miles and Milliaria.)		
England, new league of the decimal system at 32° = 10000 feet = 1000 rods = 100 chains = 10 cables = 2 old London miles	1·8945	1	3·0479
France, old post-league = 2 miles = 2000 toises	2·4229	1·2789	3·8981
Netherlands, old Amsterdam uer = 20000 feet	3·5193	1·8576	5·6621
,, old Brussels uer = 20000 feet	3·4279	1·8094	5·5150
Baden stunde = 14815 feet	2·7631	1·4585	4·4454
Bavarian stunde = 12703 feet	2·3044	1·2164	3·7075
Anspach stunde = 14400 feet	2·6823	1·4164	4·3171

LEAGUES, &c.—*continued.*	English Commercial Equivalent Miles	English Scientific Equivalent. Leagues	French Scientific Equivalent. Kilom.
Bohemian stunde = ½ grossmeile	2·8783	1·5193	4·6306
Westphalian stunde = ½ grossmeile	3·4538	1·8231	5·5567
Swiss stunde = 1600 ruthen (metric)	2·9835	1·5748	4·8000
India, Maisur hardari = 6000 gujah	3·6458	1·9245	5·8656
Burmah, dain = 1000 dha (rods)	2·4306	1·2830	3·9104
Thai (Siam), roeneng = 100 sen (chains)	2·5253	1·3330	4·0628
China, poû = 10 li	3·6116	1·9064	5·8106
Japanese ri = 12960 shaku	2·4321	1·2838	3·9129
Persia, farsakh = 6000 zar	3·8785	2·0473	6·2400

STAGES, GROSSMEILEN, POSTMEILEN, &c.

Danish miil = 4000 favn	4·6819	2·4713	7·5325
Swedish mil = 6000 famn	6·6427	3·5064	10·6872
Russian or Polish meile = 8 verst	5·3030	2·7992	8·5321
German meile = 20000 Rheinfuss	3·9015	2·0594	6·2770
Prussian postmeile (Danish)	4·6819	2·4713	7·5325
Baden meil = 2 stunden	5·5261	2·9169	8·8907
Anspach mile = 2 stunden	5·3666	2·8328	8·6342
Hanover postmeile = 25400 feet	4·6099	2·4333	7·4167
Saxony postmeile = 24000 feet	4·2233	2·2292	6·7946
Silesia, Breslau mile = 22500 feet	4·0274	2·1257	6·4790
Weimar mile = 26096 feet	4·5740	2·4142	7·3585
Austro-Hungarian mile = 4000 klafter	4·7151	2·4889	7·5859
Old Hungarian mile	5·1806	2·7346	8·3350
Bohemian grossmeile	5·7567	3·0385	9·2612
Old Lithuanian mile	5·5264	2·9170	8·8907
Old Livonian mile	4·0636	2·1446	6·5373
Old Swiss mile	5·1937	2·7415	8·3559
Later Swiss mile = 24690 feet (metric)	4·6039	2·4302	7·4070
Indian kuṅch or stage = 10 miles	10	5·2785	16·0886

JOURNEYS, AND SPECIAL UNITS.

Arabia, marhala = 24 miles = 8 farsakh	28·6411	15·1183	46·0800
Persia, journey = 10 farsakh	38·7853	20·4728	62·4000
India, Maisur gavada = 4 hardari	14·5833	7·6978	23·4625
,, ,, small gavada	10·9375	5·7734	17·5969
Madras kādum = 7 nallivalli	11·2000	5·9120	18·0193
Burma, uzena = 6400 dha	15·5556	8·2113	25·0267
Thai (Siam), yot = 4 roeneng	10·1010	5·3318	16·2511
China, tsan = 8 pou = 80 li	28·8930	15·2512	46·4846

FORMER GEOGRAPHICAL MILES AND LEAGUES, *Estimated on the old assumed metric value of the mean degree of latitude then adopted.*	English Commercial Equivalent. Miles	English Scientific Equivalent. Leagues	French Scientific Equivalent. Kilom.
Former English, American, Italian, and Dutch nautical mile = 1 minute of arc; or 60 to 1° of mean latitude	1·1513	0·6077	1·8522
Neapolitan miglio of the geodetic system (after 1840) = 1000 passi = 7000 palmi . . .	1·1513	0·6077	1·8522
China, old geodetic li of 200 to the degree (tu)	0·3454	0·1823	0·5557
Modern geodetic li of 250 to the degree (tu) .	0·2763	0·1458	0·4445
Old French, Flemish, and Dutch sea league = 3 minutes of arc, or 20 to 1°	3·4540	1·8231	5·5567
Portuguese legoa, $3\frac{1}{3}$ minutes, or 18 to 1° .	3·8378	2·0257	6·1741
Prussian, Bavarian, and Polish league = 4 minutes of arc, or 15 to 1°	4·6054	2·4308	7·4089
German and Bohemian league = 5 minutes of arc, or 12 to 1°	5·7567	3·0385	9·2612
Norwegian and Westphalian league = 6 minutes of arc, or of 10 to the mean degree of latitude	6·9081	3·6462	11·1134
Modern English nautical mile, 1 minute of longitude at the equator at sea level, subdivided into 1000 *nautical* fathoms, or 10 *nautical* cables	1·1528	0·6085	1·8547

CHAPTER III.

MEASURES OF SURFACE.

MEASURES of surface may be generally divided into two classes.

1. Ordinary commercial and artisans' measures, from the square foot to the square fathom, or small measures of surface.

2. Land-measures, from the square pace to the acre and square mile, or large measures of surface.

Such measures have necessarily from their object a high range of values, and being mostly based on the squares of the various commercial, agrarian and itinerary linear measures, and their multiples, are in general accordance with them in any thoroughly systematised set of national measures ; but this principle sometimes holds only as regards the small units.

The land-measures or measures of ground were often originally based on other considerations. Usually a small land-measure, suited to measuring building-plots in town, an ordinary agrarian measure suited to arable land pasture and vineyards, and sometimes a large one suited to forest and marsh land and to large domains, seem to have been the original requirements. Some of the smaller land-measures were probably originally based on the space covered by some local temple or public building, or the space included in the court of such

buildings ; the basic idea being evidently in many cases a rectangle of considerable length, and sometimes involving a superficial quantity that was not the square of any integral unit of length in common use ; in other cases, when the idea was taken from a square court, this anomaly did not occur.

The ordinary agrarian measure was based, in accordance with various motives, first, on the surface capable of being ploughed in a day by a man with a yoke of oxen ; secondly, on the surface capable of being advantageously sown with a certain weight or quantity of corn of some sort, naturally that most commonly grown in the country or region ; thirdly, a unit for pasture land, fixed in accordance with the number of cattle it might support by pasturage ; fourthly, a vineyard unit, based on the produce in wine measured by local measures of capacity, or on the surface tended in a day by the work of a single man.

The large land-measure may in some cases have been the extent of land that could be comprised within a periphery of strips cut from the hide of a single bullock ; and in others a mere multiple of the local agrarian measure, or a local square mile or square itinerary measure.

All these original methods of determining a unit of surface caused much deviation from anything like uniformity of result ; and eventually, when such primitive units became systematised, they were both modified in accordance with each other and with the linear measures, and the squares of the linear measures of the system of the country.

Of the building-plot type are the Italian tavola, and the old tornatura, the European square perches, square ruthen, or square poles, of the small measures. Of the

agrarian type are the ploughing units, the Roman jugerum, the acres, tagwerk, journal, and morgen, the yugada and juchart, of arable measure; also the sower's units, the ancient Egyptian series, bethcor, bethletech, bethsea, bethroba, and bethcab; the modern tunna and toendehartkorn, the cahizada, the fanegada; the stajo and starland of Italy and the Tyrol; the vineyard units, the misura, and zappada, and the old French hommée, ouvrée, fossorée, poneur, and German tauen or thauen. Of the large land-measures are the haken and hufe of Germany and Poland, suited to large extent of forest country—corresponding to the ancient Roman centuria of 100 heredies or 200 jugera, and the Roman saltus of 4 centuriæ—the old English hide of 100 acres, now declared an illegal measure, and several ancient hides of other nations; and lastly the square mile, or some topographic unit of that class.

The smallest of the commercial and artisans' measures that happens to be much used is the square foot, of which the square inch may be considered as a submultiple less frequently employed; while the largest of the land-measures is either a square mile or a hide of some sort.

THE SQUARE FOOT.

The *square foot* is in England a simple superficial unit about which there is no doubt or difficulty; in some other European countries this simplicity does not exist. In Germany in many cases there were two and sometimes three sorts of feet in a single town, one for the ordinary purposes of commerce and of the artisan, a second exclusively for land-measure, and sometimes a third either specially for the carpenter, or the stone-

mason and builder: in fact, the foot as a unit was not thoroughly digested into the German system in all cases, but remained in its transition state, being a name for either a half-cubit or half-ell or for a submultiple of the pole or ruthe. In Italy and Switzerland this ambiguity is less frequent among the feet, but occurs among the cubits or bracci. Another cause of ambiguity in connection with the German feet is due to the mode of subdivision, and its nomenclature; which is troublesome to an Englishman, for in England an inch is an inch, that is a twelfth in linear measure, but in Germany an inch may be either a tenth or a twelfth; hence a local inch may be one of six values at any one place, where there are three local feet, and both modes of subdivision. The same ambiguity extends to the square inch, which may be either the 100th or the 144th part of any one of the three local square feet. The decimal inches are hence worthy of notice, as well as the nature of the work to which it is applied. In Sweden, Prussia, Darmstadt, Baden, and Würtemberg, and at some places in Switzerland, the decimal inch is more used. In Germany the inch zoll or daumen may also be the 80th part of the lachter, and the square inch the 6400th part of the square lachter.

In England decimal multiples and submultiples of the square foot are used without involving the misplaced term, inch; they are exceedingly convenient in building, engineering, and surveying; the square of 100 square feet applied to roofing and flooring is one of these; while 108·9 squares amount to a rood or a quarter of an acre; the rood being 10890 square feet.

In Italy as well as in France, a measure of surface smaller than the square foot was formerly used, namely,

the square span, palmo quadrato or palme carré, a sub-multiple of the square canna. It was in Italy of 64 to the square canna; in France 81 to the square canna; in Sardinia, Sicily, and Pisa, 100 to the square canna; in a few places held some other ratio, and in others apparently was an independent unit; but as the metric system has been long exclusively adopted in France and Italy these values are of little consequence; the present linear Italian palmo is a decimètre, and the square palmo is a square decimètre. Similarly in the Netherlands, the palm and the vierkante palm have the same values.

But there are one or two marked exceptions where the former palmi formed sub-multiples of the land-measures, as in the stioro and quadrato of Tuscany, the moggio and carro of Naples, the rubbio and pezzo of Rome, and the starello of Sardinia. For these cases the values of the square spans or palmi are given in the tables at the end of this chapter, in addition to those of the square feet.

The following are places and provinces where special geometric land-feet or perch-feet are or were in use in addition to the ordinary or other foot.

Aachen.	Lothringen.
Elsass.	Lucerne.
Bavaria.	Mainz.
Electoral Hesse.	Nassau.
Poland.	Neufchâtel.
Flanders.	Nuremberg
Frankfurt-on-Main.	Piedmont.
Genoa.	Prussia.
Lippe-Detmold.	Savoy.
Lippe-Schaumberg.	Weimar.

THE SQUARE CUBIT.

The *square cubit* is in Germany a square ell, in Italy a square braccio, in Spain a square codo, and in Portugal a square covado, though in England an unused unit. When the German or Scandinavian ell happens to be equal to two local feet, the square ell of 4 square feet falls into the system of measures of surface ; and may be also used as a unit of measure for flooring and roofing in construction, as well as for carpets and such things. The values of these square ells may be obtained by squaring the values of the linear ells given in the last chapter. The former square bracci of Italy correspond in this respect with regard to trade requirements, but, as they rarely have any convenient ratio to the square foot, and are besides long obsolete, are of less importance generally ; there are, however, one or two exceptions. A few of the very various land-measures of Italy are based on the square braccio, and not on the square foot ; such as the tavola, staro, and biolca of Parma, the saccata, stajolo, and the quadrato of Tuscany. The values of the square bracci that might be required for such cases are hence given in the tables at the end of this chapter.

The square codo, square codo de ribera, and square covado, are not necessary submultiples of the land-measures of Spain and Portugal, which are most frequently expressed as multiples of the square vara and estado, and sometimes of the estadal ; the covado of Portugal falls entirely outside the geometric measures.

The Oriental square cubits, or square pik, seem to be unfrequently submultiples of their land-measures, which are often either based on the square pace, in accordance with the natural mode of determining a surface by

pacing two sides of a mean rectangle, or of a mean square representing it, or are based on some square perch, gassab, or vansa, and in some instances on some local square chain, square fathom or square yard.

The Indian biggah is indifferently represented as a multiple of the square hāth (cubit) or of the square gaz (yard); and though the typical biggah (that of Bengal) is one of 80 cubits square (6400 square hāth), it is probably greatly due to the varieties of gaz and hāth, and the employment of either as basic units of land-measure, that the biggahs of India present so great a variation in value.

It is as a rule most convenient to the English to represent these Indian biggahs as consisting of a certain number of square yards, but to the Indian, to deal with his more favourite unit, the hāth or cubit. But as both these units are understood by those races, and both have identical values, it becomes a matter of practical indifference.

The Arabian and Egyptian feddans are sometimes said to be based on the square cubit, and sometimes on the square pace; and this seems to be correspondingly a matter of indifference. The Arab pace (or double step), named kathuah, is not a 5-foot pace, but is a rather exceptional pace of about 6 feet—in fact, a fathom—and is divided into 4 cubits of the type dera'a cabda, although it was anciently divided otherwise. It is, however, more convenient to treat the Arabian feddan as a multiple of the square kassaba, or square perch, 400 of which go to the feddan. The Egyptian feddans are of various values, and this is probably due to the variety of cubits employed as basic units for the gassab of two paces, and thus altering the value of the pace.

The Chinese cubit, which appears to be also termed a foot (chih) and divided decimally, is sometimes employed in commerce to the exclusion of the kambuchih; so that a second system of measures of both length and surface is probably based on this separate unit. The value of this linear cubit is $14\frac{5}{8}$ English inches, or 1·21875 feet, English, making the square cubit = 1·485 feet, English.

THE SQUARE YARD.

The linear yard, and the corresponding vara of Spain and Portugal, the gaz and geza of Asia, remain unrepresented in the general measures of several European countries; the aune and stab of France and Germany, also double cubits, are applied specially to cloth-measure; and the passetto, or double cubit, of Italy is unfortunately confined to Tuscany alone. The mètre of the French metric system (originally a half-fathom) is, however, an approximate yard, adopted by several European nations, which supplies the deficiency. (Metric measures, forming a system of their own, will be treated under the head of systems of measures apart from the ordinary commercial measures.)

Existing square measures of this type generally are the highest of the commercial and artisans' measures, excepting when the square fathom, klafter, or toise is in common use; and the use of the square rod and square ruthe of England and Germany in connection with brickwork and masonry. They are sometimes, but not always, submultiples of the units of land-measure.

The values of the square yard and corresponding quantities are given in the tables.

THE SQUARE PACE.

The most expeditious and simple method of roughly measuring a plot of ground is to pace one side of an approximate square representing its area, or to pace two sides of a corresponding rectangle; and the estimation by pace therefore developed into a similar more exact mode of dealing with the pace as a fixed unit, and the larger multiples of the square pace as well-defined units of land-measure.

The versus of the ancients was one of the earliest measures of this type known to us; it consisted of 20 paces, or 100 feet square, or 400 square paces = 10000 square feet; and it certainly appears unfortunate that the Romans did not adhere to it, as the jugerum type of land-measure has led to an infinity of very inconvenient land-measures over the whole of modern Europe.

The Chinese land-measure (the king) nominally is 60000 square feet, or 2400 square paces, but, practically it appears to have been a decimal multiple of the māo in the ordinary Chinese method, being equal to 10 māo, while the māo is described as a measure 16 paces long by 15 paces broad.

Several of the land-measures of modern Europe are based on the square pace; and some values of the square pace of various nations are hence given in the accompanying tables.

Among the land-measures based on the pace are the Venetian migliajo of 1000 square passi; the misura of the Ionian Islands of 400 square paces, like the ancient versus; the Neapolitan moggio of 900 square paces; and the multiples of these—the moggio of the Ionian Islands, and the carro of Naples.

The gochih or pointung of Sumatra is a pace corresponding to the Chinese pu, and the corresponding square unit is probably used in a similar manner.

THE SQUARE FATHOM.

Nations that do not possess a yard, double-ell, or some corresponding measure, generally make use of the fathom and its submultiples in building, construction, artisans' work, &c. &c., in the same way as the English yard is applied. The same principle also applies to the square faden, square klafter, square toise, square cavezzi and trabucchi, square sasheen; and possibly also to the square depah, wa, chang, of Oriental nations.

In the preceding chapter the various corresponding linear units have been classified and valued, see pages 51–68; and it merely remains to give the values of the superficial units. Some of these square fathoms answer the purpose of a square rod, as basic units of land-measure, thus rendering a square rod a needless unit in the system, or entirely supplanting it. The Italian and South-French square canne, of about or below 36 square feet may be treated as square fathoms, or as square paces, in accordance with their dimensions, nomenclature, and history.

The more important values of the square fathom are given in the tables attached to this chapter.

LAND MEASURES.

THE SQUARE ROD.

THE *square rod* is the smallest measure of surface exclusively applied to land-measure. (See rod in Chapter II.) Taking the values of the linear rod at either 10 or 12 feet, and the general limits applied to the linear pole at 14 to 25 local feet, the values of the square rod, and of the square pole, as general expressions representing units of surface anywhere, thus come between 100 and 144, and between 196 and 625 local square feet respectively.

The terms perch and square perch are expressions applied to many units of land-measure, both canes, rods, and poles, and even square chains; but, taken philologically, the term ruthe, or rod, is a Teutonic and Scandinavian word, while the term perch is South-European, and perhaps purely Roman. The Roman pertica was the *decempede*, corresponding to the Greek, the Olympic, and the Phileterian ἀκήνη; all of which were dekapods or true rods of the strictest type—double paces. The Roman square pertica or square decempede of 100 square feet was a scruple, being the 24th part of the ounce (uncia) or the 288th of the jugerum, the basic unit, or *as* of gromatic measure. Many of the perches of Southern France and Italy were canes, half-rods, or fathoms, some were true rods, and a few Italian pertiche were by value chains. The perches of Northern France were Belgic, Flemish, or Norman units—properly poles or verges—to which the term perche was misapplied at some early date.

The square poles, though frequently considered as

mere nominal multiples of smaller units, square feet, square yards, or square fathoms, were probably by origin perfectly independent units of surface in most cases, and sometimes the feet of the system were modified or added to suit them as submultiples. Many square poles were also perhaps originally independent of the larger land-measures, though harmonised with them in the system at a later date.

Land-measures being usually arranged in a set of rather large multiples, a centesimal arrangement is particularly well suited to them; hence the convenience of the square ruthe of so many places in Germany consisting in 100 square feet; the are of 100 square mètres, and the hectare of 100 ares; a simple, primitive, and very ancient principle adopted in the versus of the ancients of 10,000 square feet, and in the Chinese decimal subdivision of the māo to the myriadth part. However inconvenient a rigid decimal system may be when applied to strictly commercial measures of capacity and of weight, where binary multiples and submultiples are almost necessary, it has great advantages both in land-measure and itinerary measure; hence the convenience of reverting to the English square rod of 100 square feet of the decimal scientific measures.

Square rods of 100 square feet are or were adopted at the following places and provinces:—

Altona.	Denmark and Norway.
Baden.	Frankfurt (special foot).
Basel.	Freiburg.
Bavaria.	Halle.
Berne.	Hesse (special foot).
Darmstadt.	Lausanne.

Lippe-Detmold (special foot).
Lothringen and Elsass.
Nassau.
Poland (precikow).
Prussia (geom. foot).
Würtemberg.
Vaud.
Vienna.
Zurich.
Tyrol.
Ancona, Bologna, and Ferrara.

The special and geometrical feet mentioned are special feet of land-measure in distinction to the werk-fuss or werkschuh.

Square rods of 144 square feet are or were in use at the following places, countries, and provinces :—

Anspach.
Prussia (ord. foot).
Emden.
Franconia.
Nuremberg (spec. foot).
Würzburg and Ost Frise.
Spain.
Malacca.
Sumatra.
India.
Burma.
Some Italian tavole.

In Italy the tavola is often the smallest unit of land-measure, corresponding to the square rod, and is generally $=4$ square cavezzi, or trabucchi $=144$ local square feet.

The exceptional tavole are those of Belluna and Treviso, which consist of 25 local square feet, and are $\frac{1}{1250}$th of the campo ; and those of Padua, Rovigo, Udine, Venice, and Verona, which consist of 36 local square feet, or are identical with the square cavezzo and are also sometimes termed square pertiche.

Returning to the Italian perches : some of them are neither subdivided into tavole nor square feet, as the

tavola and the square foot are sometimes non-existent. These exceptional cases are the Tuscan square pertiche, which consist of 25 square bracci (cubits) or of 100 square spans (palmi), and the Neapolitan pertiche. The square pertica of Naples itself is 56¼ local square palmi, but the other Neapolitan square pertiche vary at almost every town, ranging between 49 and 60 square palmi, without being well-defined integral multiples.

THE SQUARE POLE.

Small square poles were the following :—

The old Amsterdam roede . . .	169 square feet.
In Poland, Lithuania, and Silesia .	175 square feet.
Gotha (feldruthe), Erfurt, and Fulda (Hesse)	196 square feet.

Square poles of the ordinary type, 256 square feet, were in use at the following places :—

Bremen.	Mecklenburg.
Brunswick.	Neufchâtel (land-foot).
Coblenz.	Neufchâtel (werk-foot) (vineyard).
Cöln and Creveld.	Nuremberg.
Gotha (waldruthe).	Pomerania.
Hamburg.	Rostock.
Hanover.	Saxony.
Lippe-Detmold.	Stettin.
Lübeck.	Weimar.
Mainz.	

The juck or square pole of Oldenburg was 324 square feet. The square poles of the now obsolete land-measures of France, Belgium, and Holland were very various ; the most important were these :—

La perche carrée d'ordonnance . .	484	square feet
La perche de Normandie . . .	484	„
La perche commune	400	„
La perche de Paris	324	„
La verge de Bruxelles . . .	$266\frac{7}{9}$	„
Also the English square pole . .	$272\frac{1}{4}$	„

There were also Dutch, Flemish, and Belgian verges of $300\frac{4}{9}$, $336\frac{1}{9}$, $373\frac{7}{9}$, 400, and $413\frac{4}{9}$ square feet.

The present Nederlandsche vierkante roede is the square décamètre, 100 square mètres, or are of the metric system, while it is also a hundredth part of the bunder or hectare. (See Metric Systems.)

The square pole is among Northern and Scandinavian nations termed the geviert or quadrat ruthe, rode, or roede; in Belgium and the north of France the verge carrée; in southern Europe, including Southern France, the perche, or pertica, is either a rod, or a cane, or a chain—never a pole; and it must be noticed that some of the Italian square perches consist of 96 square cavezzi, or square trabucchi, and are subdivided into 24 tavole; they are then units corresponding to the square chain.

The English square pole of $272\frac{1}{4}$ square feet or $30\frac{1}{4}$ square yards is certainly inconvenient in value, both in this form and as being the 160th part of an acre, and the 102400th part of the square mile; but this inconvenience is frequently avoided by ignoring the pole, and expressing land-measure simply in acres and decimal parts, or in acres and square yards.

THE SQUARE CHAIN.

Formerly the English rood was probably quite distinct from the farthing-deal, or rectangular land-unit of 40 poles in length by one in breadth, forming the quarter of an acre, although they have been long synonymous and identical. The farthing-deal was always the fourth of the Anglo-Saxon acre, and connected with the pole; but a rood is a relic of a former unit, probably based on the original rod of 10 feet, the former having some value near 10890 square feet, perhaps 10000 or 14400, and the rod being 10 or 12 feet, the rood thus being 100 square rods. At such an epoch the rood was a convenient unit; corresponding to what is now a square chain on Ramsden's system, and probably was by origin a square chain of some ancient system.

A square chain is one of the most natural and convenient units of land-measure, dependent neither on the reputed activity of a theoretic ploughman, nor the size of the sower's corn-barrel, but on the appliance of measurement. The English square chain (Ramsden's) of 10000 square feet is also convenient as a decimal unit, besides being nearly a rood or a quarter-acre.

The values of foreign square chains and units approximating to them, which have been much neglected by metrologists, are given in the tables.

AGRARIAN MEASURES. ACRES, &C.

The *acre*, or ploughman's unit of land-measure in England, is also the ordinary unit of land-measure for all purposes. Whether based on the Roman jugerum or not, it is a measure of the same type, representing

the amount of land a ploughman can plough in a day with a yoke of oxen. The other European measures of this type are—

The tagwerk of Germany.

The tagmatt of the Tyrol.

The juchart, or joch, of Austria, Bavaria, Würtemberg, Elsass, Switzerland, and the Tyrol.

The jour and journal, formerly used in France and Belgium.

The acre of Gotha, Mecklenburg, Ravensburg, Leipzig, Weimar, Cassel, Fulda, and Normandy.

The yugada of Spain. The pose of Switzerland. The giornata of Piedmont. The geira of Portugal.

Some other European land-measures may possibly belong to this type, although there may not be sufficient evidence to demonstrate it.

The German morgen and the French arpent, or at least some of them, appear to be measures corresponding to each other. The French arpent, derived from the ancient arepenna of Gaul, which was half a Roman jugerum, was probably at one time intended for a half-acre, and, in a few cases, the German morgen was half a tagwerk. This distinction is, however, a thing of the past; the varieties of both sorts of measure obliterating it and throwing both classes into one.

The quarter-acre, now termed in England a rood, but formerly a farthing-deal,[1] had its analogous measures in Germany, France, and Italy, where quarters of some of the land-measures were termed vierling and vorling, quart and quartel, quarta and quartuccio; also the fjerdedels-tunneland of Sweden, and the quartillo of Spain.

[1] In Holland, vierendeel, or quarter.

The sower's units of land-measure, corresponding to various measures of capacity for grain, and representing the amount of land that could be advantageously sown with certain quantities of grain, are fortunately entirely unknown in England. The principle is, however, a very ancient one, adopted by the Egyptians before the Mosaic exodus. The European measures of this type are :—

The tunna or tunneland
The spannland
of Sweden.

The toendehartkorn
The toendesœdeland
The skieppehartkorn
of Denmark.

The scheffel of Hamburg, Lübeck, Rostock, Lippe-Detmold, and Oldenburg.

The metze of Austria and Bohemia.

The moggio, rubbio, and scozzo
The stajo, staro, starello, and seterée
of Italy, including Nice and Piedmont.

The starland of the Tyrol, and the setine of Switzerland.

The imbuto and corbula of Sardinia.

The saccata of Tuscany; the bacile of modern Greece.

The fanegada and cahizada of Spain, and a very large variety of old French land-measures.

The almude or celemin of the Canary Islands.

The vineyard-units of land-measure are :—

The aranzada of Spain; the thauen of Germany.

The zappada and moggio of the Ionian Islands, the fossorée of Switzerland, and, perhaps, the stremo of modern Greece, as well as several old French land-

measures, besides others that do not afford traces of their original formation or intention.

The other unassignable units of land-measure, which are either multiples or submultiples of the others, or were based on square and rectangular formation from linear measures, apart from any other object now evident, are :—

The album and penge of Denmark ; the cuadra and cuadra cuadrada of Spain and of South America ; the biolca, campo, pezzo, migliajo, quadrato, tornatura, carro, zuoja, of Italy ; the stochiaca of Tyrol ; the biggah and kani of India ; the orlong of Sumatra ; the king and mão of China ; the dessatina of Russia ; the feddan of the Levant ; as well as others.

The relation of these ordinary land-measures to the small land-measures of square perches is very varied in different localities. The following small table gives the number of square perches to the acre, morgen, or tagwerk for some of the more important cases :—

Mecklenburg, and frequently for the old French arpent	100
Bremen, Brunswick, Hanover, Lippe-Detmold	120
Gotha and Weimar	140
Franconia	144
Aachen, Bamberg, Cöln, Creveld, Hesse, Würtemberg, and Lothringen	150
England, Gotha, Coblenz, Frankfurt, Mayence, Normandy, Nuremberg, and Würzburg	160
Erfurt	168
Prussia and Würzburg	180
Elsass	240

Baden (Constance)	260
Saxony (Leipzig), Lithuania, Poland, Pomerania, Silesia	300
Zurich	320
Oldenburg	356
Anspach, Basel, and Zurich	360
Würtemberg	384
Baden, Bavaria, Darmstadt, Würtemberg, Geneva	400
Hamburg, and occasionally near the Rhine	600

The ratios to the small measures of some of the former Italian land-measures, and those of countries other than France and the Netherlands, are given in the tables. The former land-measures of France were very numerous, intensely complicated, and varied much in value. The following is a rather incomplete list of them:—

Acre	Hommée	Port
Arpent	Jallois	Pugnère
Boisserée	Journée	Punière
Boisseau	Journal	Quartier
Bicherée	Jour	Quart
Carré	Latte	Quartel
Carreau	Mesure	Raie
Chaînée	Mesurée	Reges
Concade	Mine	Sadon
Corde	Minée	Salmée
Danrée	Mouée	Seterée
Eminée	Œuvre	Setier
Escat	Ouvrée	Seytive
Faucheur	Pauque	Sillon
Faux	Perche	Verge
Fossorée	Picotin	Vergée
Grande mesure	Place	Vertison

Some of these measures had several, and some many, values. The Belgian bunder had an infinity of values.

The perusal of such lists, and reflection on the confusion involved in the variety of their values, will demonstrate the cause of the avidity of the French, Belgians, and Italians for the metric system, which is specially well suited to land-measure, and will also show that no similar eagerness can be expected in a country like England, where there is only one acre, not only in the mother-country, but wherever English measures are used.

LARGE AGRARIAN UNITS. HIDES, &C.

The *hide* was a large land-measure, consisting of 100 acres, formerly used in England, but now legally obsolete ; the measures of Germany and Poland, that are slightly analogous, are the haken and the hufe, or wloka.

The following are the ratios of these measures to the local morgen :—

Pomerania: haken = 15 morgen, also termed the Wendische hufe, or Vandal hufe ; the priester-hufe of 20 morgen, the land-hufe of 30 morgen. Also the tripel-hufe of 3 haken, and the haeger-hufe of 4 haken.

Kœnigsberg: the haken of 20 morgen and the hufe of 30 morgen.

Berlin, *Breslau*, *Danzig*, *Frankfurt-on-the-Main*, and Hesse: the hufe of 30 morgen.

Mecklenburg: the hufe of 400 acres.

Poland: the haken of 20 morgow, and the hufe, or wloka of 30 morgow.

The domain-unit, or estate-unit, appears almost as necessary a part of a complete system as an agrarian unit; the English hide being now obsolete, its place may be supplied by the unit of the decimal system termed a *century*, in accordance with Roman nomenclature, which is equal to 100 square chains, or nearly the same number of roods. This unit also serves to complete the system, in other respects being a square cable, or the square of a cable 1000 feet long, and also the hundredth part of a square league of the same series.

TOPOGRAPHICAL MEASURES.

The *square mile* is a recognised superficial unit of surface in England, being exactly 640 acres. The square kilomètre of the metric system is in the same way an integral multiple of the hectare, and the Chinese square li an integral multiple of the māo and the king, but though some such relation may also exist in some other countries and places, it is comparatively rare. In some countries very large units are wanting, numerical multiples being used instead of determined units; in others square geographical miles or leagues of various sorts are employed; but these are generally detached units, not coalescing in the general system.

The square league of the English decimal series consists of 100 centuries, or 10000 square chains (Ramsden's); and as the linear league = 2 Old London miles of 5000 feet, the square league is 4 square miles of the Old London type. The series is hence complete in surface measure, is centesimal throughout, and has a wider scope than the French system, with which it is parallel in some respects.

SQUARE FEET.

NATIONAL AND GENERAL.	English Commercial Equivalent. Sq. feet	English Scientific Equivalent. Sq. feet	French Scientific Equivalent. Déc. car.
The square foot of England, America, and Russia, their colonies and dependencies, duod.	1	0·9994	9·2846
The scientific value of the same at 32° Fahr.	1·0006	1	9·2900
The square foot of Prussia, Norway, and Denmark	1·0609	1·0603	9·8504
The square geometric foot of Prussia for land	1·5277	1·5269	14·1846
The square foot of Sweden and Finland, dec.[1] and duod.	0·9492	0·9487	8·8130
The square foot of the Austro-Hungarian Empire, dec. and duod.	1·0760	1·0754	9·9907
The square foot of Spain generally, duod.	0·8344	0·8339	7·7469
,, ,, Portugal, duod.	1·1729	1·1722	10·8900
,, ,, Arabia	1·1029	1·1022	10·2400
,, ,, the Chinese Empire, dec., the Board of Works kambuchih	1·1223	1·1217	10·4206

FORMER, LOCAL, OR SPECIAL SQUARE FEET.

GERMANY :—

Prussia, Imperial quadrat Rheinfuss	1·0609	1·0603	9·8504
,, geometric quadrat Feldfuss	1·5277	1·5269	14·1846
Anspach and Baireuth, duod.	0·9680	0·9674	8·9880
Altona and Hamburg, duod.	0·8440	0·8835	8·2077
Baden, metric dec.	0·9693	0·9688	9·0000
Bavaria, dec. and duod.	0·9174	0·9169	8·5182
Rhenish Bavaria, metric duod.	1·1967	1·1960	11·1111
Bremen, dec. and duod.	0·9008	0·9003	8·3635
Brunswick, duod.	0·8771	0·8766	8·1432
Cöln and Aschaffenberg	0·8909	0·8904	8·2714
Culm	0·8940	0·8935	8·3002
Dantzig, duod.	0·8864	0·8859	8·2303
Elsass (Stadtschuh)	0·9008	0·9003	8·3637
Elsass (Landschuh)	0·9373	0·9367	8·7025

[1] The feet are marked decimal when the inch is a decimal submultiple of the foot.

SQUARE FEET—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
GERMANY :—	Sq. feet	Sq. feet	Déc. car.
Gotha, duod.	0·8910	0·8905	8·2724
Halle (Werkfuss)	0·8973	0·8968	8·3309
,, (Feldfuss, of 1½ Werkfuss)	2·0189	2·0177	18·7446
Hanover, duod.	0·9183	0·9178	8·5261
Heiligenstadt and Erfurt	0·8632	0·8627	8·0149
Hesse Darmstadt, metric dec.	0·6732	0·6728	6·2500
Hesse-Electoral, forest foot, duod.	0·8915	0·8910	8·2771
,, $\frac{1}{14}$ perch, field foot	0·8742	0·8737	8·1168
,, $\frac{1}{10}$ perch, dec. field foot	1·7138	1·7128	15·9121
Holstein	0·9597	0·9591	8·9103
Lippe-Detmold and Schaumburg	0·9028	0·9023	8·3818
Lothringen ordinary square foot	0·8805	0·8800	8·1754
,, square field foot	0·9550	0·9544	8·8667
Lübeck and Rostock	0·8927	0·8922	8·2887
Mecklenburg	0·9121	0·9115	8·4682
Nassau, metric quad. Werkfuss, dec.	0·9693	0·9687	9·0000
,, metric quad. Feldfuss, dec.	2·6926	2·6910	25·0000
Nuremberg, metric quad. Stadtfuss	0·9944	0·9938	9·2331
,, ,, Artilleriefuss	0·9259	0·9253	8·5966
Oldenburg	0·9463	0·9458	8·7862
Saxe-Weimar, quad. Werkfuss, duod.	0·8564	0·8559	7·9512
Saxe-Weimar, quad. Feldfuss, dec.	2·1923	2·1910	20·3551
Saxony, Dresden, duod.	0·8632	0·8628	8·0149
,, Leipzig, dec. and duod.	0·8605	0·8600	7·9894
Silesia (Prussian)	0·8633	0·8928	8·2919
Würtemberg, dec.	0·8840	0·8835	8·2077
SWITZERLAND :—			
Berne and Freiberg, square foot	0·9463	0·9457	8·6000
Basel, square foot	0·9987	0·9981	9·2743
Saint Gall, square foot	1·0187	1·0181	9·4586
Geneva, square foot	2·5644	2·5629	23·8098
Glaris, Grisons, Uri, Waadt, Valais, Schweitz, square foot	0·9693	0·9687	9·0000
Lucerne, ordinary square foot	1·0609	1·0603	9·8504
,, joiners' ,, ,,	0·9944	0·9938	9·2329
,, for land and works	0·8701	0·8696	8·0789
Neufchâtel, Landfuss	0·9463	0·9457	8·6000
,, Feldmessfuss	0·8880	0·8875	8·2451
Rheinfelden, Arau	1·0760	1·0754	9·9907
Schaffhause, Werkschuh	0·9558	0·9552	18·8744
Ticino, square brazzetto	1·6975	1·6965	5·7609
Zug, Halberstab quad.	0·9693	0·9687	9·0000
,, quad. Steinschuh	0·7776	0·7771	7·2200
Zurich, Halberstab quad. field	0·9693	0·9687	9·0000
,, builders' measure	0·9695	0·9698	9·0015

SQUARE FEET—*continued.*

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Sq. feet	Sq. feet	Déc. car.
France :—			
Pied du roi, Parisian square foot	1·1365	1·1359	10·5521
Pied métrique (from 1812 to 1840)	1·1967	1·1960	11·1111
Holland and Belgium :—			
Amsterdam, vierkante voet = 121 v. duimen	0·8632	0·8628	8·0149
Brussels, vierkante voet = 121 v. duimen	0·8190	0·8185	7·6038
Austro-Hungary :—			
Imperial square foot, dec. and duod.	1·0760	1·0754	9·9907
Bohemia, ,, ,,	0·9462	0·9456	8·7853
Galicia ,, ,,	0·9487	0·9491	8·8180
Illyria, Trieste, square foot, duod.	1·0896	1·0890	10·1168
Moravia, square foot	0·9437	0·9431	8·7616
Poland, Cracow square stopa, duod.	1·3681	1·3673	12·7021
Silesia (Austrian), square foot	0·9020	0·9015	8·3752
Tyrol, square foot	1·2023	1·2016	11·1630
Russia :—			
Imperial square foot, duod.	1	0·9994	9·2846
Lithuania ,, ,,	1·1365	1·1358	10·5521
Revel ,, ,,	0·7618	0·7613	7·0733
Riga ,, ,,	0·8091	0·8086	7·5119
Pernau ,, ,,	0·8104	0·8099	7·5240
Poland (Warsaw), square stopa, duod.	0·9612	0·9606	8·2944
,, ,, square precikow, dec.	2·0100	2·0088	18·6624
Italy :—			
Ancona, square foot	1·8067	1·8057	16·7748
Bergamo ,, ,,	2·0644	2·0632	19·1669
Bologna ,, ,,	1·5561	1·5552	14·4476
Brescia ,, ,,	2·3893	2·3879	22·1841
Cremona ,, ,,	2·5178	2·5163	23·3772
Mantua ,, ,,	2·3474	2·3460	18·7952
Milan ,, ,,	2·0399	2·0387	27·9399
Modena ,, ,,	2·9466	2·9449	12·3579
Padua and Vicenza, square foot	1·3758	1·3750	12·7735
Parma, square foot	3·1948	3·1929	19·6630
Piacenza ,, ,,	2·3781	2·3767	22·0796
Piedmont, piede manuale, 8 in.	1·2634	1·2627	11·7306
,, piede liprando, 12 in.	2·8429	2·8412	26·3955
Reggio, square foot	3·0357	3·0339	28·1855
Rome (piede = $1\frac{1}{3}$ palmo) $\frac{16}{9}$ square palmo	0·9558	0·9552	8·8744
Savoy, Chambéri square foot	1·2407	1·2400	11·5192
Venetia, square foot	1·2998	1·2991	12·0687
Verona, square foot	1·2665	1·2658	11·7586

SQUARE FEET—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
SPAIN :—	Sq. feet	Sq. feet	Déc. car.
Castile, square foot, duod.	0·8344	0·8339	7·7469
Aragon ,, ,,	0·7114	0·7110	6·6049
Valencia ,, ,,	0·9843	0·9837	9·1385
AMERICA :—			
Mexico, Buenos Ayres and Monte Video, Chili, Peru, La Havana, duod. (old value of the Spanish square foot)	0·8608	0·8603	7·9919
Pernambuco square foot, duod.	0·9947	0·9941	9·2355
Quebec (pied du roi, Parisian), duod.	1·1365	1·1359	10·5521
INDIA :—			
Malabar, square ady	0·7599	0·7593	7·0554
CHINA :—			
Board of Works square kambuchih	1·1223	1·1217	10·4206
Imperial survey of 1700, square chih	1·0167	1·0161	9·4396
Square chih of the Tsing dynasty since 1644	1·0998	1·0992	10·2112
Local values.[1]			
Canton customs, square chih	1·3806	1·3798	12·8184
Pekin palace ,, ,,	1·0795	1·0789	10·0227
,, imperial statistics square chih	1·0677	1·0671	9·9132
,, tribunal of math. ,, ,,	1·1952	1·1945	11·0979
,, board of works ,, ,, (?)	1·0574	1·0568	9·8175
,, land ,, ,,	1·1511	1·1504	10·6875
Shanghai land revenue ,, ,,	1·2065	1·2058	11·2018
,, shipbuilders' ,, ,,	1·7116	1·7106	15·8916
Special value of the square chih frequently used in land-measure as a sub-multiple of the mau, $\frac{1}{6000}$th part	1·1968	1·1961	11·1118
JAPAN :—			
Square shaku ordinary	0·9819	0·9813	9·1167
Special value, as a square land-foot, the myriadth part of the ittau	1·0715	1·0709	9·9484
MANILA :—			
The Castilian square foot	0·8344	0·8339	7·7469

N.B.—Some of the old values of square feet, having been deduced through old Parisian measure, will not be exact squares of linear values, given in metric or English terms.

[1] For other values of Chinese square feet, square the English linear values on p. 54.

SQUARE CUBITS.

SQUARE ELLS, SQUARE BRACCI, &c.	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Sq. feet	Sq. feet	Déc. car.
Square cubit, English half yard squared	2·250	2·249	20·891
Scientific value of the same at 32° Fahr.	2·251	2·250	20·903
Square ell of Prussia, 4·5157 square feet	4·790	4·788	44·476
Square ell of Norway and Denmark, 4 sq. ft.	4·244	4·241	39·401
Square ell of Sweden and Finland, 4 sq. ft.	3·796	3·794	35·248
Square ell of Austria, not much used; replaced by the square klafter	6·539	6·535	60·715
Square codo ordinario of Spain, $2\frac{1}{4}$ square feet	1·877	1·876	17·431
Square codo de ribera of Spain, 4 square feet	3·338	3·336	30·991
Square covado of Portugal, 4 square feet	4·692	4·689	43·560
Square covado do commercio, Portugal, $24\frac{3}{4}$ inches square	4·989	4·986	46·322
Square braccio of Tuscany, 4 square palmi	3·668	3·666	34·059
square palmo of Tuscany	0·917	0·917	8·515
Square braccio di legno of Parma (this is also termed an agrarian foot)	3·166	3·164	29·393
Square braccio of Naples, $7\frac{1}{9}$ square palmi	5·258	5·255	48·818
square palmo of Naples	0·739	0·739	6·864
Square braccio of Rome, 16 square palmi	7·745	7·740	71·910
square palmo of Rome, $\frac{9}{16}$ square foot	0·538	0·538	4·992
Square arsheen of Russia, $5\frac{4}{9}$ square feet	5·444	5·441	50·545
Square pik endesa of Stambul	5·088	5·085	47·238
Square pik of Patras, Oran, Scio, and Jerusalem	5·069	5·066	47·060
Square pik of Aleppo and Alexandretta	4·926	4·923	47·738
,, ,, endeza of Cairo	4·389	4·386	40·755
,, ,, endeza of Alexandria	4·282	4·279	39·753
,, ,, of Cyprus	4·857	4·854	45·098
,, ,, of Abyssinia	5·066	5·063	47·032
,, ,, of Bassara	4·880	4·877	45·306
Square hāth of India and Burmese taim, and Sumatra esto	2·250	2·249	20·891
Square sandang of Burmah	3·361	3·359	31·201
Square cubit of commerce of China, also termed a foot; decimally divided	1·486	1·486	13·801

SQUARE DOUBLE CUBITS.

Square yards, mètres, varas, pasetti, &c.

GENERAL VALUES.	English Commercial Equivalent. Sq. yds.	English Scientific Equivalent. Sq. feet	French Scientific Equivalent. Mèt. car
Square yard of England and America, square gaz of India: 9 square feet, or 36 square cubits (hath), or 256 square nails	1	8·995	0·8356
The scientific value of the same at 32° Fahr.	1·0006	9·000	0·8361
Mètre carré of France, Holland, and Belgium, metro quadrato of Italy, &c., divided decimally	1·1967	10·764	1
Vara cuadrada of Spain = 9 pies cuad. = 256 avas cuad.	0·8344	7·505	0·6972
Vara cuadrada of Portugal = 9 pes cuad.	1·4480	13·024	1·2100

FORMER, LOCAL, OR SPECIAL VALUES.

FRANCE :—			
Demi-toise car. (ancienne)	1·1364	10·221	0·9496
Demi-toise car. métrique (1812 to 1840)	1·1967	10·764	1
Aune carrée (ancienne)	1·6903	15·204	1·4124
Aune carrée métrique (1812 to 1840)	1·7233	15·501	1·4400
SPAIN AND AMERICA :—			
Castilian vara cuadrada	0·8344	7·505	0·6972
Aragonese ,, ,,	0·7113	6·398	0·5944
Barcelona ,, ,,	0·7207	6·483	0·6022
Galician ,, ,,	1·4102	12·685	1·1784
Valencian ,, ,,	1·0358	9·317	0·8655
Vara cuadrada of Peru, Chili, Mexico, Buenos Ayres, Montevideo, and La Havana	0·8606	7·741	0·7191
Vara cuadrada of Canary Islands	0·8480	17·628	0·7086
,, ,, of Brazil	1·3262	1·929	1·1816
ITALY :—			
Tuscan pasetto quad. = 16 palmi quad.	1·6304	14·665	1·3624
Roman stajolo quad. = $33\frac{1}{16}$ palmi quad.	1·9751	17·765	1·9504
ORIENTAL COUNTRIES :—			
Arabia, Mokha square gaz	0·4825	4·340	0·4032
Persia,[1] square zar'	1·2944	11·643	1·0816
India, Imperial square gaz	1	8·995	0·8356
,, Bombay square gaz	0·5625	5·060	0·4700

[1] Square Measures are not generally used.

THE SQUARE PACE.

GENERAL VALUES.	English Commercial Equivalent. Sq. pace	English Scientific Equivalent. Sq. feet	French Scientific Equivalent. Mèt. car.
Square pace of England and America = 25 square feet	1	24·993	2·3211
The scientific value of the same at 32° Fahr.	1·0006	25	2·3217
Square pace of Germany in ordinary quad. schritt = 25 square Rheinfuss.	1·0609	26·508	2·4626
Square pace of Germany, geodetic quad. schritt = 42·706 square feet of Hamburg	1·4777	36·930	3·4299
Pas carré de France = 25 pieds carrés de Paris	1·1365	28·396	2·6380
Pas carré of 25 pieds carrés métriques	1·1967	29·901	2·7777
Paso cuadrado of Spain = 25 square pies	0·8344	20·848	1·9367
Passo cuadrado of Portugal = 25 square pes	1·1729	29·306	2·7225
Ionian Islands, 25 square feet (Venice)	1·2998	32·478	3·0172
Patras, 25 square feet (Paris)	1·1365	28·396	2·6380
Square pu[1] of China, 25 square chih of the Board of Works	1·1223	28·042	2·6050
Square gochih of Sumatra, 25 square chih; or depa, 16 square cubits	1·4400	35·976	3·3420

FORMER, SPECIAL, OR LOCAL VALUES.

Square pace, Hamburg, ordinary 23·04 sq. feet	0·815	20·36	1·891
Square step, Berne, 9 square feet	0·333	8·33	0·774
Square pace, Berne, 25 square feet	0·946	23·64	2·1500
Square pace, Trieste, 25 square feet	1·090	27·23	2·529
Rome, 25 piede quad.	0·956	23·88	2·2219
Tuscany, 9 bracci quad.	1·321	33·00	3·0660
Napoli,[1] 56·25 palmi quad.	1·664	41·57	3·8610
Venezia, 25 piede quad.	1·300	32·48	3·0176
Bologna, 25 piede quad.	1·556	38·88	3·6119
Milan	1·177	29·41	2·7320
Square step, French Antilles, 12¼ square feet	0·557	13·92	1·293

[1] This is also a square fathom.

SQUARE FATHOMS.

Lachters, klafters, toises, sasheens, estados.

GENERAL VALUES.	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent
	Sq. yards	Sq. feet	Mèt. car.
English square fathom = 36 square feet, rarely used	4	35·979	3·3425
Value of the same at 32°	4·0023	36	3·3444
Danish and Norwegian square favn = 36 square feet	4·2437	38·172	3·5461
Swedish square famn = 36 square feet	3·7968	34·152	3·1727
Prussian square klafter = 36 square feet	4·2437	38·172	3·5461
,, square berglachter = $44\frac{4}{9}$ square feet	5·2390	47·134	4·3778
Austrian square klafter = 36 square feet	4·3042	38·715	3·5967
Russian square sasheen = 49 square feet	5·4444	48·972	4·5495
Spanish square estado = 36 square feet	3·3375	30·021	2·7889
Malacca and Sumatra square depah = 16 square cubits	4	35·979	3·3425

FORMER, LOCAL, OR SPECIAL VALUES

GERMANY :—			
Bavaria, square klafter = 36 square feet	3·6698	33·009	3·0665
Bremen, geviert klafter = 36 square feet	3·6031	32·410	3·0109
Darmstadt, square werkklafter = 100 square feet	7·4795	67·277	6·2500
Frankfurt, square klafter = 36 square feet	3·4899	31·391	2·9162
Hamburg, square klafter = 36 square feet	3·5360	31·806	2·9548
Hanover, square klafter = 36 square feet	3·6732	33·040	3·0694
Lothringen, toise carrée = 36 square feet	3·5223	31·682	2·9433
Saxony, Dresden, square klafter = 36 square feet	3·4530	31·059	2·8854
Saxony, Leipzig, square klafter = 36 square feet	3·4420	30·960	2·8762
Saxony, Leipzig, square lachter = 49 square feet	4·6850	42·141	3·9149
Weimar, geviert klafter = 36 square feet	3·4256	30·813	2·8625
Würtemberg, geviert klafter = 36 square feet	3·5360	31·806	2·9548
SWITZERLAND :—			
Metric square toise = 100 square feet	10·7704	96·879	9
Berne, square klafter = 64 square feet	6·5864	59·243	5·5037
Freiberg, square werkklafter = 100 square feet	10·2919	92·574	8·6001
Geneva, square toise = 64 square feet	8·0818	72·695	6·7533

SQUARE FATHOMS—*continued.*

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Sq. yards	Sq. feet	Mèt. car.
SWITZERLAND :—			
Lausanne, square toise = 100 square feet . .	10·7704	96·879	9
Neufchâtel, square toise = 100 square feet. .	10·2919	92·574	8·6001
Neufchâtel, square toise for hay = 36 square feet	3·7051	33·327	3·0961
Zürich, square klafter = 36 square feet . .	3·8774	34·876	3·2400
FRANCE :—			
Toise carrée ancienne = 36 square feet . .	4·5460	40·891	3·7988
Toise carrée métrique = 36 square feet . .	4·7869	43·057	4
RUSSIA :—			
Pernau square faden = 36 square feet . .	3·2383	29·146	2·7060
Polish square sazen = 36 square stopa . .	3·5734	32·142	2·9860
Revel, square faden = 36 square feet . .	3·0483	27·419	2·5472
Riga, square faden = 36 square feet . . .	3·2383	29·146	2·7060
ITALY :—			
Turin, square tesa = 25 square feet (p. manuale)	3·5100	31·572	2·9330
Savoy, square tesa = 64 square feet (Chambéri).	8·8225	79·358	7·3732
Bergamo	8·257	74·28	6·900
Brescia	9·558	85·97	7·986
Cremona	10·071	90·59	8·416
Milan	8·160	73·40	6·818
Modena	11·786	106·01	9·849
Padua and Vicenza — Italian square cavezzi of 36 square feet	5·503	49·50	4·598
Piacenza	9·513	85·56	7·949
Reggio	12·143	09·33	10·147
Trevisa	7·175	64·54	5·996
Venice	5·199	46·77	4·345
Verona	5·066	45·57	4·232
Mantua, square cavezzo = 36 square bracci .	17·858	150·62	14·922
Tuscany, square cavezzo = 36 square bracci .	14·673	131·99	12·261
Sardinia, square trabucco = 144 square palmi .	11·875	106·81	9·923
Piedmont, square trabucco = 36 square feet .	11·372	102·29	9·502

SQUARE RODS.[1]

GENERAL UNITS.	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Sq. yards	Sq. rods	Mèt. car.
England and America, square rod of 100 square feet; at 62° normal temp.	11·111	0·9994	9·2847
The same at the temperature of 32°.	11·117	1	9·2900
Square rod of Denmark and Norway = 100 square feet	11·786	1·0603	9·8504
Square stöng of Sweden = 100 square fot	10·547	0·9487	8·8130
Square rod of Prussia = 144 square feet = 100 geometric square feet	16·975	1·5269	14·1846
Square rod of Austro-Hungary = 100 square feet; (superseded by the square klafter)	11·956	1·0754	9·9907
Square estadal of Spain = 144 square feet.	13·350	1·2008	11·1556
Square gasab of Arabia = 144 square feet.	17·646	1·5873	14·7456
Square dha of Burmah = 49 square royal cubits.	18·209	1·6460	15·2913
Square jumba of Malacca, Square tung of Sumatra } = 64 square cubits.	16·000	1·4392	13·3698
Square chang of China = 100 square feet (B. Works)	12·471	1·1217	10·4206
Square jaktan of Guinea.	16·014	1·4404	13·3810

LOCAL, FORMER, OR SPECIAL UNITS

GERMANY :—

Prussian square rod = 144 square feet	16·975	1·5269	14·1846
Anspach ,, = 144 ,,	15·489	1·3932	12·9427
Baden ,, = 100 ,,	10·770	0·9688	9·0000
Bavaria ,, = 100 ,,	10·194	0·9169	8·5182
Elsass ,, = 100 ,,	10·009	0·9003	8·3637
Hesse-Darmstadt, square rod = 100 square feet	7·479	0·6728	6·2500
Holstein, square rod = 100 square feet	11·788	1·0603	9·8504
Lothringen ,, = 100 ,,	9·783	0·8799	8·1754
Nürnberg ,, = 144 ,,	15·912	1·3222	13·2957
Würtemberg ,, = 100 ,,	9·822	0·8835	8·2077

[1] For units greater than double paces or double fathoms see Poles and Square Poles.

SQUARE RODS—*continued.*	English Commercial Equivalent.	Scientific English Equivalent	French Scientific Equivalent.
SWITZERLAND :—	Sq. yards	Sq. rods	Mèt. car.
Berne and Freiberg, square rod = 100 sq. ft.	10·514	0·9457	8·6000
Basel, square rod = 100 square feet	11·097	0·9981	9·2743
Geneva ,, 64 Parisian square feet	8·082	0·7269	6·7533
Waadt, Valais, square rod = 100 square feet	10·770	0·9688	9·0000
Zürich, square rod = 100 square feet	10·772	0·9689	9·0015
BELGIUM :—			
Square rod = 100 square feet (Brussels)	9·099	0·8185	7·6038
AUSTRIA :—			
Cracow, sq. pretow = 100 square stopa	15·201	1·3673	12·7021
Tyrolese square rod = 100 square feet	13·358	1·2016	11·1630
ITALY :—			
(Former Tavole.)			
Bergamo, tavola = 4 square cavezzi = 144 sq. ft.	33·031	2·9710	27·6003
Cremona, tavola = 4 square cavezzi = 144 sq. ft.	40·286	3·6236	33·6632
Milan, tavola = 4 square cavezzi = 144 sq. ft.	32·639	2·8358	27·2735
Modena, tavola = 4 square cavezzi = 144 sq. ft.	51·404	4·6237	39·3954
Piacenza, tavola = 4 square cavezzi = 144 sq. ft.	38·177	3·4339	31·7946
Piedmont, tavola = 4 square trabucchi = 144 sq. feet, also termed a square pertica	45·488	4·0915	38·0095
(Square Pertiche.)			
Ancona square pertica = 100 square feet	20·075	1·8057	16·7748
Bologna ,, ,, ,,	17·290	1·5552	14·4476
Ferrara ,, ,, ,,	19·518	1·7556	16·3098
Naples ,, = 56¼ square palmi	4·622	0·4153	3·8617
Parma ,, = 36 square bracci	12·664	1·1390	10·5814
Tuscany ,, = 25 square bracci	10·190	0·9165	8·5147
Venice, square pertica or tavola = 36 sq. ft.	5·199	0·4677	4·3447
Verona, square pertica or tavola = 36 sq. ft.	5·069	0·4557	4·2331

Some Italian square pertiche consist of 24 tavole or 96 square cavezzi. For these see Square Chains.

SQUARE POLES.

GENERAL VALUES.	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Sq. yards	Sq. rods	Mèt. car.
English square pole = $30\frac{1}{4}$ square yards or $272\frac{1}{4}$ square feet	30·250	2·721	25·2775
Square roede of Sweden = 64 square ahn or 256 square feet	27·000	2·429	22·5613
Are of the metric system of France; metric tavola of Italy; vierkante nederlandsche roede of Holland and Belgium = 100 mètres carrés .	119·672	10·764	100
Greece, Patras stremo = 25 square paces = 625 square feet	78·923	7·099	65·9500

LOCAL, FORMER, OR SPECIAL VALUES.

GERMANY :—

Bremen, square ruthe = 64 square ells . .	25·622	2·305	21·4106
Brunswick ,, ,, . .	24·828	2·244	20·8465
Cöln ,, = 256 square feet . .	25·341	2·305	21·1747
Erfurt ,, = 196 ,, . .	18·800	1·691	15·7093
Gotha, square feldruthe = 196 square feet . .	19·404	1·745	16·2139
,, ,, waldruthe = 256 ,, . .	25·343	2·280	21·1774
Halle, square ruthe = 225 square feet . .	22·432	2·018	18·7446
Hamburg, square marschruthe = 49 square ells .	19·252	1·732	16·0870
,, ,, geestruthe = 64 square ells .	25·146	2·262	21·0116
Hanover, square ruthe = 64 square ells . .	26·120	2·349	21·8268
Hesse, Electoral, square ruthe = 196 square feet	19·021	1·711	15·9102
Lippe-Detmold, square ruthe = 256 square feet .	25·679	2·310	21·4574
Mecklenberg, square ruthe = 256 square feet .	25·943	2·334	21·6786
Nürnberg, square ruthe = 256 square feet . .	28·287	2·544	23·6367
Oldenberg, juck = 324 square feet . . .	34·067	3·064	28·4674
Saxe-Weimar, square ruthe = 256 square feet .	24·748	2·226	20·3551
Saxony, Dresden, square ruthe = 256 square feet	24·555	2·209	20·5182
,, Leipzig, square ruthe = 256 square feet	24·476	2·202	20·4529
Silesia (Prussian), sq. ruthe = 225 square feet .	22·327	2·008	18·6568

SWITZERLAND :—

Neufchâtel, common sq. perche = $245\frac{4}{9}$ sq. feet .	25·261	2·272	21·1083
,, for vineyards = 256 square feet .	26·348	2·370	22·0160

SQUARE POLES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Sq. yards	Sq. rods	Mèt. car.
FRANCE :—			
Perche car. = 25 toises car. (mes. usuelles)	119·672	10·764	100
,, de Paris = 324 square feet	40·915	3·680	34·1887
,, commune = 400 square feet	50·513	4·543	42·2083
,, des eaux et forêts = 484 sq. feet	61·120	5·498	51·0720
HOLLAND AND BELGIUM :—			
Amsterdam, vierkante roede = 169 square feet	16·210	1·458	13·5452
Brussels, vierkante roede = 266$\frac{7}{9}$ square feet	24·276	2·184	20·2853
,, ,, verge = 400 square feet	36·398	3·274	30·4152
AUSTRIA :—			
Silesian square ruthe = 225 square feet	22·550	2·028	18·8442
RUSSIA :—			
Warsaw, sq. pretow = 225 square stopa	22·333	2·009	18·6624
INDIA :—			
Bengal, kattah = 80 square gaz = 16 chittack = 320 square hāth	80	7·1959	66·8492
Madras, kuli = 64 square gaz	64	5·7567	53·4836
Malabar, square kuli = 576 square ady	48·655	4·3765	40·6572
Trichinopalli, square kolu	49·780	4·4775	41·5975
Indian revenue gunta = 4 square poles	121	10·8840	101·1100
ANAM :—			
Square sao = 9 square ngu = 225 square cubits or thaoc	64	5·7567	53·4836
CHINA :—			
The fan of surface measure is the tenth of the mao, and = 24 square pu (paces) or kung = 600 square chih. (For values reduce from the mao, or square chih.)			
Board of Works value of fan	74·825	6·7302	62·5236
JAPAN :—			
Ijje = 30 subo	119·082	10·7112	99·5067

SQUARE CHAINS AND ANALOGOUS UNITS.

GENERAL VALUES.	English Commercial Equivalent. Roods	English Scientific Equivalent. Sq. ch.	French Scientific Equivalent. Ares
England, the rood = 40 sq. poles = 1210 sq. yds.	1	1·0884	10·1110
Scientific value of the rood at 32° Fahr. . .	1·0006	1·0890	10·1168
The Ramsden square chain of 10000 square feet = 100 square rods	0·9183	0·9994	9·2847
Its scientific value at 32° Fahr., the unit of the English decimal system	0·9188	1	9·2900
The Gunter's square chain of 484 square yards, or 16 square poles	0·4000	0·4354	4·0444
Sweden, square ref = 100 square stänger = 10000 square fot	0·8716	0·9487	8·8130
Germany, square chain = 10000 square Rheinfuss	0·9742	1·0603	9·8504
Danzig, square seil = 22500 square feet . .	1·8315	1·9934	18·5182
Königsberg, square schnur = 22500 square ft. .	2·1069	2·2930	21·3022
France, Holland, Belgium, and Italy, square chain = 400 mètres carrés	0·3956	0·4306	4
Bohemia, square waldseil = 1764 square ells .	0·6155	0·6699	6·2232
,, sq. weinbergseil = 4096 square ells .	1·4292	1·5555	14·4502
Poland, square snurow = 22500 square feet .	1·8458	2·0088	18·6624
Tyrol, starland = 10000 square feet . . .	1·1041	1·2017	11·1630
Spain, celemin = 768 varas cuad. . . .	0·5296	0·5764	5·3547
Valencia, sq. cuerda = 1600 sq. varas . .	1·3696	1·4906	13·8474
Naples, square catena = 64 square passi . .	0·2444	0·2661	2·4715
,, also sq. catena = 100 square passi .	0·3825	0·4157	3·8617
Rome, square catena[1] = 100 square stajoli. .	0·1633	0·1777	1·6508
Bergamo, square pertica[2] = 96 cavezzi quad. .	0·6551	0·7130	6·6241
Cremona ,, ,, ,, .	0·7991	0·8697	8·5792
Milan ,, ,, ,, .	0·6474	0·7046	6·5456
Piacenza ,, ,, ,, .	0·7547	0·8214	7·6307
Greece, Ionian Islands, misura = 3 zappade = 10000 square feet = 400 square paces . .	1·1936	1·2991	12·0687
Arabia, square chain = 100 square gassab . .	1·4581	1·5873	14·7456
India, sq. tenab = 2500 sq. gaz (yards) . .	2·0661	2·2487	20·8902
,, square jarib = 3600 square gaz illahi, of the North-West Provinces	2·5	2·7210	25·2775
Thai (Siam), sq. sen = 400 sq. wa (fathoms) .	1·6325	1·7768	16·5061
China, square yu = 100 square chang = 10000 square chih.	1·0341	1·1217	10·4206
Japan, ittau = 10 ijje	0·9841	1·0711	9·9507

[1] This small unit is termed a chain, though corresponding in value to a large pole.
[2] These are very exceptional pertiche.

LAND MEASURES, ACRES, &c.

GENERAL VALUES.	English Commercial Equivalent. Acres	English Scientific Equivalent. Sq. ch.	French Scientific Equivalent. Hectares
England, America, and parts of India: acre = 4 roods = 160 square poles = 4840 square yards.	1	4·3535	0·4044
The scientific value of the same at 32° Fahr. .	1·0006	4·3560	0·4047
Sweden: tunnland = 218¾ square poles = 56000 square feet = 2 spannland = 8 fjerdingar. .	1·2203	5·3125	0·4935
Denmark: toendehartkorn = 2240 square rods = 2 toende-soedeland = 224000 square feet .	5·4557	23·7513	2·2065
Prussia: morgen = 180 sq. rds. = 25920 sq. ft. .	0·6313	2·7484	0·2553
France, Holland, Belgium, and Italy: hectare = 100 ares = 10000 mèt. carrés; ettaro or tornatura = 100 tavole; nederlandsche bunder = 100 vierkante roeden	2·4726	10·7643	1
Austro-Hungarian Empire: joch or jochart = 3 metzen = 576 square rods = 1600 square klafter = 57600 square feet	1·4229	6·1945	0·5755
Russia: dessätina = 2400 square sasheen = 117600 square feet	2·6997	11·7532	1·0919
Spain: fanegada = 12 celemin = 576 estadales cuad. = 9216 varas cuad.	1·5888	6·9167	0·6426
Portugal: geira = 4840 varas cuad. . . .	1·4480	6·3040	0·5856
Greece: Ionian I., moggic = 24 zappade = 3200 square paces = 8 misure = 80000 square feet .	2·3919	10·4130	0·9674
Arabian feddan = 400 square rods = 57600 sq. ft. (also used in Turkey and Egypt)	1·4584	6·3490	0·5898
Malacca and Anam: sq. orlong or mao = 400 sq. jamba = 1600 sq. depa (fathoms) = 100 sq. sao	1·3223	5·7567	0·5[illegible]48
China: king[1] = 10 mao = 6 square yu (B. of W.)	1·5512	6·7302	0·6252
Common king = 10 mao	1·6495	7·1810	0·6671
Shanghai king = 10 mao	1·6666	7·2560	0·6741
Macao king = 10 mao	2·0981	9·1341	0·8486
Canton king = 10 mao	2·0631	8·9817	0·8344
Japan ichchu = 10 ittau = 100 ijje	2·4604	10·7112	0·9951

FORMER, LOCAL, OR SPECIAL VALUES.

GERMANY:—		Local sq. ft.			
Prussian morgen	= 180 sq. rods .	25920	0·6313	2·7484	0·2553
Anspach ,,	= 400 ,, .	51840	1·1521	5·0155	0·4659
Baden ,,	= 400 ,, .	40000	0·8901	3·8751	0·3600
Bavaria, tagwerk	= 400 ,, .	40000	0·8425	3·6677	0·3407

[1] The king is also considered ten times these values, or = 100 mao.

ACRES—*continued.*

		Local sq. ft.	English Commercial Equivalent. Acres	English Scientific Equivalent. Sq. ch.	French Scientific Equivalent. Hectares
GERMANY :—					
Bremen, morgen	= 120 sq. poles .	30720	0·6353	2·7656	0·2569
Brunswick ,,	= 120 ,, .	30720	0·6185	2·6928	0·2502
Cöln ,,	= 150 ,, .	38400	0·7853	3·4190	0·3176
Danzig ,,	= 300 ,, .	67500	1·3736	5·9802	0·5556
Elsass, arpent	= 240 sq. rods .	24000	0·4963	2·1536	0·2007
Erfurt, acker	= 168 sq. poles .	32928	0·6526	2·8409	0·2639
Gotha, feldacker	= 140 ,, .	27440	0·5613	2·4434	0·2270
,, waldacker	= 160 ,, .	40960	0·8378	3·6474	0·3388
Hamburg, morgen	= 600 ,, .	117600	2·3866	10·3899	0·9652
Hanover ,,	= 120 ,, .	30720	0·6476	2·8194	0·2619
Hesse-Darmstadt, morgen	= 400 sq. rods	40000	0·6181	2·6911	0·2500
Holstein, toende	.	225280	5·4868	23·8871	2·2191
Kürhesse, acker	= 150 sq. poles .	29400	0·5901	2·5689	0·2387
LippeDetmold, morgen	= 120 ,, .	30720	0·6367	2·7717	0·2575
Lothringen, arpent	= 250 sq. rods .	25000	0·5054	2·2001	0·2044
Mecklenberg, acker	= 100 sq. poles .	25600	0·5360	2·3336	0·2168
Nassau, morgen	= 100 sq. rods .	10000	0·6181	2·6911	0·2500
Nuremberg, acker	= 160 ,, .	23040	0·5260	2·2899	0·2127
,, morgen	= 200 sq. poles .	51200	1·1689	5·0887	0·4727
Pomerania, ,,	= 300 ,, .	76800	1·6205	7·0545	0·6554
Saxony, Leipzig, acker	= 300 ,, .	76800	1·5171	6·6048	0·6136
Würtemberg, morgen	= 384 sq. rods .	38400	0·7793	3·3926	0·3152
SWITZERLAND :—					
Basel, juchart	= 360 sq. rods .	36000	0·8255	3·5939	0·3339
Berne, acker	= 400 ,, .	40000	0·8506	3·7029	0·3440
Freiberg, juchart	= 500 ,, .	50000	1·0632	4·6287	0·4300
Lucerne ,, (large)	.	45000	0·8989	3·9134	0·3636
,, ,, (small)	.	31250	0·6242	2·7176	0·2525
Waadt ,,	= 500 ,, .	50000	1·1126	4·8439	0·4500
Zürich ,,	= 400 ,, .	40000	0·8903	3·8758	3·3601
Geneva, pose	= 400 sq. toises	25600	0·6679	2·9078	0·2701
FRANCE :—					
Arpent de Paris	= 100 sq. poles .	32400	0·8453	3·6802	0·3419
,, commun	= 100 ,, .	40000	1·0436	4·5434	0·4221
,, d'ordonnance	= 100 ,, .	48400	1·2628	5·4976	0·5107

The old French units were excessively numerous.

HOLLAND AND BELGIUM :—				
Amsterdam, juchart = 300 sq. poles	. .	1·0047	4·3741	0·4064
,, morgen = 600 ,,	. .	2·0095	8·7483	0·8127
Brussels, dagwand = 100 ,,	. .	0·5016	2·1836	0·2029
,, bunder = 400 ,,	. .	2·0063	8·7343	0·8114

The old units varied excessively in value.

ACRES—*continued.*	Local measure	English Commercial Equivalent. Acres	English Scientific Equivalent. Sq. ch.	French Scientific Equivalent. Hectares
AUSTRO-HUNGARY :—				
Austrian joch = 3 metzen = 576 square rods 1600 square klafter = 57600 square feet		1·4229	6·1945	0·5755
Tyrolese jauchart = 1000 square klafter = 36000 square feet of Vienna		0·8899	3·8745	0·3599
Botzen, tagmatt = 4 starland = 5 grabe = 400 square rods = 40000 square feet		1·1041	4·8066	0·4465
Polish morgow = 300 square pretow = 67500 square feet = 3 square snurow		1·3843	6·0266	0·5599
SPAIN :—				
Ordinary fanegada = 9216 square varas		1·5888	6·9167	0·6426
Small fanegada = 8000 square varas		1·3792	6·0041	0·5578
Aranzada = 6400 square varas		1·1033	4·8033	0·4462
Valencian cahizada = 6 Valencian fanegadas		1·0272	4·4717	0·4154
Valencian yugada = 6 cahizadas		6·1629	26·8304	2·4925
Canary I., fanegada = 600 sq. brasadas		0·4935	2·1484	0·1996
ITALY :—	Local sq. ft.			
Bologna, biolca = 196 sq. rods	19600	0·7002	3·0481	0·2832
Ferrara ,, = 400 ,,	40000	1·6131	7·0225	0·6524
Modena ,, = 72 tavole	10368	0·7013	3·0533	0·2837
Parma ,, = 72 ,,	10368	0·7535	3·2799	0·3047
Padua and Vicenza campo = 840 tavole	30240	0·9551	4·1579	0·3863
Venice, campo = 640 tavole	20340	0·6875	2·9931	0·2781
,, migliajo = 1000 sq. passi	25000	0·7460	3·2478	0·3017
Verona, campo = 720 tavole	25920	0·7536	3·2808	0·3048
Piedmont, moggio = 96 ,,	13824	0·8008	3·4861	0·3239
,, giornata = 100 ,,	14400	0·9398	4·0915	0·3801
Lombardy, tornatura = 100 metric tavole		2·4726	10·7643	1
Naples, moggio = 900 square passi		0·8393	3·7411	0·3475
Rome, rubbio = 112 square catene		4·5705	19·8977	1·8485
,, quarto = 28 ,, ,,		1·1426	4·9744	0·4621
Sardinia, starello = 576 square rods		0·9814	4·2724	0·3969
Tuscany, quadrato = 400 ,, ,,		0·8421	3·6662	0·3406
,, saccata = 660 ,, ,,		1·3895	6·0492	0·5620
INDIA :—	Sq. yds.			
Bengal, biggah = 20 kattah	1600	0·3306	1·4392	0·1337
Benares and Ghazipur, biggah	3136	0·6479	2·8208	0·2620
Northern India, biggah	3025	0·6250	2·7209	0·2528
Orissa, biggah	4840	1	4·3535	0·4044
Tirhut ,,	4225	0·8729	3·8003	0·3530
Madras, kani = 100 kuli	6400	1·3223	5·7567	0·5348
Bombay, biggah = 20 pund	3406	0·7037	3·0637	0·2846

LARGE LAND MEASURES, HIDES, &c.

GENERAL VALUES.

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Hides	Sq. cab. or cent.	Hectares
England : the (obsolete) hide = 100 acres . .	1		40·444
England : the century of the decimal scientific system = 1 square cable = 100 square chains = 10000 square rods = 1000000 square feet .	0·2297	1	9·2900
Prussian haken = 20 morgen	0·1263	0·5497	5·1065
,, hufe = 30 ,, ...	0·1894	0·8245	7·6597
,, grosshufe = 66⅔ morgen . . .	0·4209	1·8322	17·0215
Pomeranian haken = 15 ,, ...	0·2431	1·0583	9·8312
,, landhufe = 30 ,, . . .	0·4862	2·1165	19·6623
,, hæger hufe = 60 morgen . .	0·9723	4·2330	39·3246
Mecklenberg hufe = 400 acker	2·1441	9·3342	86·7145
Rostock hufe = 450 acker = 600 scheffeln . .	2·4121	10·5010	97·5538
Spain : yugada = 50 fanegadas. . . .	0·7944	3·4584	32·1281
Polish : haken = 20 morgow	0·2769	1·2053	11·1974
,, hufe or wloka = 30 morgow. . .	0·4153	1·8080	16·7962
Bombay chahar = 120 biggah	0·7037	3·6764	34·1532

SQUARE MILES AND SQUARE LEAGUES.

	Sq. miles	Sq.leag.	Sq. kilom.
England : square statute mile = 64 square furlongs = 640 acres	1	0·2786	2·5884
Former square London mile = 2500 square chains at 62° Fahr.	0·8960	0·2499	2·3212
London square mile = 2500 square chains at 32°	0·8973	0·25	2·3225
London square league of the decimal scientific system = 100 centuries or square cables = 10000 square chains = 4 square London miles	3·5891	1	9·2900
France : kilomètre carré = 100 hectares . .	0·3863	0·1076	1
,, mille itinéraire car. = 1 million toises car.	1·4667	0·4089	3·7987
France : lieue de poste car. = 4 milles car. .	5·8704	1·6356	15·1950
Germany : square postmeile (Danish) . .	21·9201	6·1075	56·7383
,, square geographic meile (of 15 to 1°)	21·2069	5·9088	54·8923
Spain : legua cuad. (geogr. of 17½ to 1°) . .	15·5806	4·3411	40·3290
Portugal : legoa cuad. (geogr. of 18 to 1°) .	14·7270	4·1033	38·1196
India : square kos = 4 million square yards .	1·2913	0·3598	3·3425

CHAPTER IV.

CUBIC MEASURES AND UNITS OF CUBICITY.

THE principal distinction between measures of capacity and cubic measures, as regards their origin, consists in the former having been deduced from measures of weight and the latter from the cubes of linear measures in common use. In a perfect system of measures, the whole fall into unison, and become corresponding in every respect.

The attempt to carry out this principle to perfection was made in the design and operations for laying down the metric system. A litre, the basic unit of capacity, was to be cubic décimètre ; and the measures of weight were to be based on the weight of water contained in the litre. Practically one kilogram, the 'kilogramme des archives,' was actually made to equal as near as possible the weight of a litre of water at 39° Fahrenheit, or 4° Centigrade ; but as the standard temperature for the metric system was 0° Centigrade or 32° Fahrenheit, the anomaly of the vessel being required at one temperature, and the water at another, prevented its being done with actual precision ; and hence computation had to be depended on for making allowance to suit the case. Since then, that kilogram, whether right or faulty, has been enshrined, secluded strictly from public gaze, and

not even weighed in water by scientific men in private on account of some alleged deterioration that might occur owing to a supposed presence of soluble arsenic in the platinum ; hence its density is unknown. This cannot be termed a very scientific basis for measures of weight, though doubtless well suited to public veneration ; yet the standard metric weights of Europe are copies of an inexact copy of this kilogram. The ancient Egyptians may have built pyramids as mural standards of measure, the Romans may have laboriously adapted the Greek and the Egyptian measures to practical purposes and wants ; were the English to reconstruct their metrical system they would scientifically weigh a cubic yard, or at least a cubic foot of water, but the French alone would make a single miserable cubic décimètre weight of such pretensions, borrow decimalisation from the Chinese, and propagate the result by presents of Sèvres vases, large medals, and sentiments of mutual admiration.

One kilogram, however, being thus made, the litre has ever since not been a cubic décimètre, but a measure of capacity containing such a kilogram-weight of distilled water at its maximum density. In other words the French eventually fell back on the old system of making their measures of capacity in accordance with their measures of weight ; in the same way as in England the gallon was made to contain ten pounds' weight of distilled water. There would apparently have been no necessity for this abandonment of intention, if the temperature of 4° Centigrade had been adopted as the standard for the system throughout.

The cubic measures of a system may hence be distinct from the measures of capacity, both in origin and in

fact. This is more especially the case in England where the measures of capacity are based on the legal idea that a cubic foot of water weighs 62·321 pounds of water at the temperature of 62° Fahrenheit—a value believed to be incorrect; so that there are two causes of departure affecting the two series as regards unison and uniformity.

In England, therefore, we have a standard gallon and a standard cubic foot based on linear measures that are not in accordance; and in order to compare the sets of measures dependent on each of them with real accuracy, we must assume some approximately correct weight of a cubic foot of water either at 62° Fahrenheit, or at 39° Fahrenheit and at 32° Fahrenheit.

Taking the values as nearly as can be possibly deduced from Miller's results (See 'Philosophical Transactions,' 1856), they are :—

At 39° Fahrenheit . .	62·4245 lbs.
„ 62° „	62·3548 „
The legal enactment giving	62·321 „

There is, however, another legal definition of an English gallon, namely, that it contains 277·274 cubic inches; while a cubic inch of water weighed in air was also declared to weigh 252·458 grains at a temperature of 62° Fahrenheit and a barometric pressure of 30 inches.

If this side of the matter be taken in preference to the other, and the advantages of the law be made use of, the bushel then becomes 2218·192 cubic inches; and on this basis the cubic measures and the measures of capacity may be compared in one system. Any error will then be thrown into the weight, and into the whole of

the series of English commercial measures of weight; this will be treated in a succeeding chapter.

Having thus arrived by a legal subterfuge at a single system of measures, formed by the coalition of the capacity and the cubic measures, it may be first noticed that the whole English series is comparatively small, extending from the minim to the bushel in capacity, and to the cubic yard in cubic measure; everything beyond this, such as a vat, a barrel, &c., being a calculated and a numerical rather than an actual practical measure; and it may secondly be remarked that the capacity-measures are mostly those of ordinary retail and trade and simple commerce, while the cubic measures are mostly those of technical business and work involving skilled or technical labour.

In Germany, under their old system—which appeared to be intended to suit every special branch to the utmost—there were not only decimal feet and decimal perches to suit the land-surveyor, and the cubic foot, klafter, and rod to suit artisan's work; there was also the berglachter system of measures to suit mining operations. The berglachter, or lachter of about a fathom, was taken as the unit, and a complete system based on it, both in Prussia and Saxony. There were thus sometimes four systems co-existent, one based on the foot for ordinary purposes, one on the ruthe and its decimal submultiples through a special land-foot, a partial system on the ell, and another on the common klafter, and on the lachter.

The unity of the English cubic measures is in striking contrast to these, in a manner exactly corresponding to the singleness of the English land-measures, contrasted with the multifarious old land-measures of France.

CUBIC MEASURES.

Among all European nations that possess a linear foot as a measure, the cubic foot forms a cubic measure. Its decimal subdivision into thousandths, and its duodecimal subdivision in 1728 cubic inches, are both convenient, when used so as not to interfere with each other or cause confusion ; and either one method or the other, or both, appear to be adopted indifferently.

The independent ell, not forming any simple multiple of the foot, is seldom cubed ; and when the ell is a simple multiple, the numerical advance in point of measure is so small as not to render it very useful ; hence it is only when the foot is unknown or little used that the cubit, or ell, becomes sufficiently important to be cubed and used in cubic measure.

The cubic yard, or cube of a double cubit, exists in England and America, in Spain and Portugal, and in India ; other nations being deficient in this useful natural unit, with the sole exception of the Florentine passetto, a double cubit now declared to be obsolete. Its place is supplied by the mètre of the French metric system, and the cubic mètre ; its decimal subdivision has the advantage of convenience in numerical calculation in large numbers, but not so in small differences, as cubic quantities increase very rapidly with the cubes ot the corresponding linear dimensions ; the subdivision into 27 cubic feet is certainly more convenient for this latter reason ; and the cubic foot thus forms a fresh point of departure. The absence of any cubic foot, or measure corresponding to a cubic foot, is hence a marked defect in a system, which is not compensated by any measure near the cube of a tenth of a yard, or any

cubic décimètre. In fact, the entire absence of the cubic yard itself would not be so serious, as its place might be well supplied either by decimal multiples of the cubit foot, or by submultiples of the cubic fathom.

The cubic fathom, klafter or lachter, toise, favn, braza or estado, is necessarily most used by nations that do not possess a cubic yard of any sort. The fathom, originally the embrace of the outstretched arms, or about the height of a man, is a measure of about 6, or from 5 to 7 feet, and is usually an aliquot or multiple. The cubic fathom hence is generally either 216 or 343 cubic feet in a series of measures; the exceptions being the large cubic werkklafter, lachter, berglachter, and cubic toise of Prussia, Darmstadt, and Switzerland, which are decimal multiples of the cubic foot, or of some special cubic foot, and are fixed at 1000 cubic feet. However convenient these may be for purposes of numerical calculation, they are not, strictly speaking, cubic fathoms, but fall in the next higher class of measure—cubic rods.

The cubic rod, or cube of the rod of land-measure, is sometimes supplemented in German measures by a special cubic rod adapted to artisans' work, masonry, and building, and these, when real cubic rods of either sort, are multiples of the cubic foot in one class or the other. In England the real cubic rod is hardly ever mentioned as such—multiples of the cubic yard, or of the cubic foot, being used instead; but a nominal rod of brickwork, a cubic measure formed on a square pole of surface by a thickness of a brick and a half of such bricks as are most commonly used, is still used; it is a mere term for about 306 cubic feet, or $11\frac{1}{3}$ cubic yards of brickwork in walling. Corresponding measures of this type of parallelopipedon are, or were, used in

Germany and France; of these the following are instances :—

The Prussian schachtruthe is a square rod by a foot of thickness, and is 144 cubic feet in masonry and earthwork.

The Prussian feldsteinruthe is a term for 120 cubic feet.

In Saxony the cubic rod for ashlar is $7\frac{1}{2}$ ells long $\times$ 8 broad $\times$ $1\frac{1}{2}$ high, or 90 cubic ells $=720$ cubic feet.

At Frankfurt-on-the-Main there are two cubic rods, the ordinary one 12 feet long $\times$ 6 broad $\times$ 4 high $=$ 288 cubic feet; the mason's rod 12 feet long $\times$ 13 broad $\times$ 2 high $=$ 312 cubic feet.

In Hesse there are two rods, the ordinary one of 12 feet long $\times$ 6 broad $\times$ 4 high $=$ 288 cubic feet; the mason's rod is 144 cubic feet only.

In France there were, besides the real toise-cube of 216 cubic feet, the cubic measure known as the toise-toise-pied of 36 cubic feet, and the toise-toise-pouce of 3 cubic feet.

It may be noticed that such contrived measures were peculiar to countries that did not possess a cubic yard measure, and served a useful purpose under such purposes. In England there is no excuse for the retention of the nominal rod of brickwork as a measure of $11\frac{1}{3}$ cubic yards, as brickwork, being dependent on the chance-size of a burnt brick, the uniformity of the bricks, the size of the mortar joints and the shrinkage of the work, does not demand a specially exact measure, and can be estimated in cubic yards or cubic feet. Units of fuel-measure, stacks and cords, are most frequently incongruous; their values range from the cubic yard to the cubic fathom, mostly between 40 and 200 local cubic

feet. Tons by bulk are from 40 to 60 cubic feet in value. A few special loads, voies, carrate are also cubic units. The English ton of 40 cubic feet is an excellent unit for binary subdivision, and would serve well as a basis for rearrangement of capacity-measures down to the bushel or the cubic foot.

The extremes of cubic measure, hence, are the cubic inch and the cubic rod ; and the arrangement of the measures between these two extremes is diversely effected in accordance with local habit, both in accordance with the preferred linear units and the mode of subdivision adopted. The natural subdivision based on the ordinary values of linear measures is thus :—

1728 cubic inches = 1 cubic foot ; 27 cubic feet = 1 cubic yard ; 216 cubic feet or 8 cubic yards = 1 cubic fathom ;

and if we take the one *typical* value of the linear rod, the double fathom, then—

1728 cubic feet = 64 cubic yards = 8 cubic fathoms
= 1 cubic double fathom ;

and there becomes a binary subdivision throughout exactly corresponding to that of the cubic foot into cubic inches ; this typical arrangement was adopted in Prussia, in some parts of Germany, and in Spain, while the corresponding principle was applied to some square measures in Italy, the tavola being often a square of 12 feet or 144 feet. Such is the typical and natural binary mode of subdividing cubic measures, which possesses great advantages in continual halving. The other mode of subdivision is decimal, any of these measures being taken as a basis. Taking the *other typical* value of the linear rod used by the Romans, Greeks, Arabs, and

Egyptians, which is more natural, the double pace of 10 feet, then—

1 cubic rod = 1000 cubic feet; and 1 cubic foot = 1000 fluid ounces.

The cubic foot, being the most intermediate measure is the most convenient for several reasons, as the thousandth of a cubic foot is near $1\frac{3}{4}$ cubic inch (1·728); and a thousand cubic feet is a measure nearly 37 cubic yards, being 37·037 cubic yards, or 4·64 cubic fathoms. Also with the English cubic foot, the thousandth part has the additional advantage of very closely representing the quantity of water that weighs an ounce.

Decimalisation on the cubic yard, the cubic fathom, and the cubic inch would have less practical convenience, as the thousands and the thousandths or mils, which are the important points in a system of cubic measures, do not fall in useful positions.

The relations existing between the English cubic units, inches and feet, that is both of the binary and of the decimal scale, and the units of capacity are shown in small comparative tables, following on pages 119–122: these clearly demonstrate the superior advantage of the foot and decimal-ounce units. While considering the position of these various units of cubicity with regard to each other, it becomes also imperative to notice their position with regard to corresponding English units of weight, and more especially in the lower part of the scale, applied in the compounding of the druggist, and in the smaller operations of the scientific chemist, analyst, and experimentalist in natural science.

Small English Units.—The thousandth part of a cubic foot of water weighs nearly an ounce, and it would be well if the ounce were very slightly adjusted

to be exactly in correspondence ; also the fluid-ounce is a legal measure of capacity, containing an ounce-weight of water, a permanent binding connection between the measures of weight and of capacity that is convenient, like that of the cubic foot and the foot-weight.

The fluid-ounce is divided into 480 minims, and the ounce-weight into 437·5 grains, and hence a minim is not a grain-weight of water. Also the fluid-ounce is divided into 8 fluid-drams, while the ounce-weight is divided into dram-weights of two sorts, one the commercial dram, which is the sixteenth of the ounce, or 27·344 grains, the other, the medical dram of 60 grains, neither of which correspond to the weight of a fluid-dram of water ; thus the English small measures of capacity below the fluid-ounce are at present neither convenient in their relation to cubic measure, nor in connection with measures of weight.

This anomalous arrangement will doubtless be eventually swept away and adjusted, not by lapse of time, but by someone that possesses the courage, ability, and influence necessary to have it done. Probably the best plan would be the following :—

1. To make the ounce and the fluid-ounce exactly the 1000th of the foot-weight and the cubic foot of present English measures.

2. To subdivide both this ounce and this fluid-ounce into ten drams and fluid-drams, also into 400 grains and fluid-grains respectively.

3. To abolish the whole of the old avoirdupois units, and substitute for them the corresponding English units which differ from them very slightly, only $\frac{3}{10}$ per cent.

The attached small tables illustrate the connection of the decimal submultiples of the cubic foot and of the

cubic inch with the existing series of small measures of capacity and of weight.

Comparison of Small Measures of Capacity with those of Cubic Measures and of Weight.

By Subdivision of the Cubic Foot.

Cubic Measure		Capacity	Weight
Cub. ft. after adjustment	Cub. ft. legal measure	Minims	Grains
·001 cub. ft. or 1000 mils	1003	1 fluid-oz. (480 m.)	1 ounce-weight (437·5 grs.)
137·2 mils	137·6	(65·826 minims)	1 medical dram (60 grs.)
125· mils	125·4	1 fl.-dram (60 m.)	54·69 grains drm.
62·5 mils	62·68	(30 minims)	1 commercial drm. (27·344 grs.)
2·286 mils	2·293	(1·0971 minims)	1 grain
2·083 mils	2·089	1 minim	0·9115 grain
1 mil	1·003	(0·48 m.)	0·4375 grain

By Subdivision of the Cubic Inch.

Cubic Measure		Capacity	Weight
Cubic inches after adjustment	Cubic inches legal measure	Minims	Grains
1·728	1·7329	1 fluid-oz. (480 m.)	1 ounce weight (437·5 grs.)
	1	0·577 fluid-oz. (276·9 m.)	0·577 oz. (252·4 grs.)
0·2238	0·2377	(65·826 m.)	1 medical dram (60 grs.)
0·216	0·2166	1 fl.-dram (60 m.)	(54·69 grs.)
0·103	0·1083	(30 m.)	1 commrcl. dram (27·34 grs.)
0·00373	0·00396	(1·0971 minim)	1 grain
0·0034	0·00361	1 minim	(0·9115 grs.)

From these it will be seen that these measures are in ill-accordance with the cubic inch, both at present, and even under the supposition that the ounce be adjusted so as to be made exactly to the weight of 1000th part of a cubic foot of water; but under this latter supposition the fluid-dram is exactly 125 myriadths of a cubic foot, and the myriadth of a cubic foot is nearly half a minim, 0·48 minim—a convenient relation that now holds good approximately. There is no such convenient relation between the cubic measures and the existing grain or its decimal multiples: the advantage of correspondence being solely in the cubic foot and the ounce.

Continental nations generally have no small measures of capacity, such as minims and fluid-drams, as they compound simply by weight in their old measures; the adoption of the metric system which has a cubic centimètre, about one-fourth of the English fluid-dram, is hence a considerable advantage to them in this respect.

Large English Units.

The accordance between the English cubic measures and the large measures of capacity as well as with those of weight is almost as unfortunate as in the case of the very small measures; in fact nowhere, excepting at the fluid-ounce and ounce-weight, and at the cubic foot and foot-weight, is there any identity of principle.

The legal capacity of the gallon is 277·274 cubic inches, and the legal weight of a gallon of water is 10 pounds; the gallon being the standard English unit of capacity on which the whole of the rest of the capacity-measures are based. These form an excellent binary series from the bushel down to the quarter-gill, and are

hence thoroughly adapted to commercial purposes; but from the basic unit, the gallon, being in ill-accordance with the cubic measures, the whole series suffers in the way already explained.

One approximation to adjustment which now exists, and may hereafter be made perfect, is the connection through the fluid-ounce and ounce-weight.

The gallon consists of 8 pints, the pint of 20 fluid-ounces; hence, as the gallon is 277·274 cubic inches, the ounce is its 160th part, or is 1·7329 cubic inches, which is very nearly 1·728 cubic inches, or the 1000th of a cubic foot. Taking it at exactly that value, the gallon would proportionately become 276·48 cubic inches, or 0·160 cubic foot exactly; and the whole series of measures of capacity would then be in accordance with cubic-measure as a result of the small adjustment of 0·003 per unit, or $\frac{3}{10}$ths per cent. evenly throughout the whole.

Although this is doubtless a matter of the future, and not of the present, as regards the fact, it is yet now a convenient mode of arriving through calculation from cubic measure to capacity-measures and the converse, which is in itself important, whether the adjustment of the $\frac{3}{10}$ths be made at an early date, in the dim future, or never.

The legal equivalents of the English measures of capacity, from the quarter to the pint, as well as the weights of water they contain, are given in the attached table. There are still higher measures, the wey or load of 5 quarters, and the last of 10 quarters, which constitute an unfortunate departure from a nearly perfect binary system; there are also subdivisions on the binary scale, from the pint down to the quarter-gill of $1\frac{1}{4}$ fluid-

ounces ; thus making in all 14 measures of a strictly binary formation, which are perhaps unequalled anywhere as regards their commercial convenience, although not yet scientifically adjusted to cubic measure.

Comparison of the Larger Measures of Capacity with Cubic Measure and Weight.

	In actual fluid oz.	Actual Legal Capacity in Cubic Inches	Adjusted or approximate Capacity in Cubic Feet[1]	Weight of water contained
Quarter	10240	17745·536	10·24	640 pounds
Coomb	5120	8872·768	5·12	320 ,,
Strike	2560	4436·384	2·56	160 ,,
Bushel	1280	2218·192	1·28	80 ,,
Half-bushel	640	1109·096	0·64	40 ,,
Peck	320	554·548	0·32	20 ,,
Gallon	160	277·274	0·16	10 ,,
Pottle	80	138·637	0·08	5 ,,
Quart	40	69·318	0·04	$2\frac{1}{2}$,,
Pint	20	34·659	0·02	$1\frac{1}{4}$,,
Fluid-ounce	1	1·7349	0·001	$\frac{1}{16}$ or 1 oz.

In addition to the natural cubic measures before referred to, which in England do not go beyond the cubic yard, there are terms of cubic measure that are convenient multiples of the cubic yard, or of the cubic foot ; such as the various loads, lasts, and tons of measurement which are not to be confused with the lasts, loads, and tuns of capacity, the latter being multiples of the bushel or of the gallon.

The real cubic measures are mostly fuel and wood measures, and shipping tons, as before mentioned. Even some of the old English measures of capacity were deter-

[1] These quantities are nearly $\frac{3}{10}$ per cent. *less* than the legal capacities.

mined in cubic measure, although they may have been originally based on weight of corn or of flour. The Winchester bushel was $2150\frac{1}{2}$ cubic inches, and the Winchester gallon was $274\frac{1}{4}$ cubic inches; the Elizabethan ale-gallon was 282 cubic inches, and the Queen Annian wine-gallon 231 cubic inches. The present gallon of 277·27384357 cubic inches is an invention dating only from the reorganisation of 1825.

The inherent defect of the present English capacity measures is that they are dependent on an old French avoirdupois pound, which cannot coalesce in the English measures without some slight alteration. Beyond that there is the anomalous two-temperature standard under which weight and capacity are compared.

Foreign Units.

While the English cubic measures are not in strict accordance with the commercial measures of capacity, the same may be said of a very great number of cubic measures of other nations. The fact that the litre is no longer a cubic décimètre in reality, but is a measure of capacity containing a kilogram weight of water, in accordance with a primitive kilogram of unknown density, has been already mentioned. The Russians, in the same way as the English, have hitherto conformed their measures of capacity to those of weight; thus their vedro of liquid measure is 30 local pounds of water and their tschetverik 64 pounds. The Turkish fortin and the kiloz are based on weight of wheat, the former being 2 canthars, the latter 22 oka, and the alma is 8 oka of oil. The Iberian almudes and arrobas are now nominally based on weight of water in some cases and on weight

of oil in others; formerly they were Arab or Moorish makuk and waebe, or true cubic measures of another series, which cannot coalesce with the cubic units of the Visigoths and Suevi. It cannot, therefore, be expected that measures of capacity formed on this principle, and rigidly adhered to, can be in strict accordance and uniformity with the cubes of the linear measures of the nation, until some mode of adjustment be adopted to effect a real systematisation. It seems that this habit of neglecting the accordance between cubic and capacity-measures is not only unscientific, but is a marked evidence of a want of ordinary civilisation.

The ancient Egyptians, the Chaldæans, the Assyrians, the Persians, the Ptolemaic Egyptians, and the Greeks, all deduced their weights from their cubic measures and subdivided large cubic measures to form small measures of capacity, when they required them; although there is no doubt that Oriental nations did not much use capacity-measures, and preferred buying and selling almost everything by weight; but the mode of making measures of capacity to suit old foreign units of weight, without considering their relation to true local cubic measure, is a proceeding suited to savage tribes, destitute of apparatus, appliances, and scientific men.

The whole series of Swedish units of capacity are actual cubic units (see Swedish system).

The Prussians and the Danes, as well as some of the former German nationalities, regulated their measures of capacity by cubic measure, as may be seen by the attached table giving the values.

EQUIVALENTS OF MEASURES OF CAPACITY IN LOCAL CUBIC MEASURE.

Danish pot or krug	$\frac{1}{32}$ of a cubic foot
Danish kanne	108 cubic inches
Danish bushel	972 cubic inches
Danish corn-barrel	$4\frac{1}{2}$ cubic feet
Danish tar-barrel	$3\frac{3}{4}$ cubic feet
Danish grain last	99 cubic feet
Prussian scheffel	3072 cubic inches
Prussian eimer	3840 cubic inches
Prussian beer-barrel	6400 cubic inches
Prussian malter	$21\frac{1}{3}$ cubic feet
Lubeck scheffel	2343 cubic inches
Lippe-Detmold scheffel	3154 cubic inches
Bavarian scheffel	8944 cubic inches
Dresden scheffel	8064 cubic inches
Gotha bergscheffel for coal	2920 cubic inches
Bavarian schankeimer for wine	2580 cubic inches
Castilian fanega	4440 cubic inches

Zurich grain malter, $12\frac{1}{4}$ cubic feet; vegetable malter, $12\frac{1}{3}$ cubic feet; lime malter, 12 cubic feet; charcoal malter, $27\frac{1}{2}$ cubic feet.

In other parts of Europe the cases of capacity-measures in strict accordance with cubic measure are detached and comparatively rare; most of them are based on weight, the weight-units being generally old, borrowed, and foreign; thus preventing these national collections of units from being perfect in systematisation, or deserving of being named systems.

In Oriental countries capacity-measures hardly exist, or are comparatively rare. In Pagan countries, capacity-measures are mostly based on weight of grain, and

sometimes are deductions from weighing several sorts of grain; in some places they do not exist, but are supplanted by direct weight; and in very few, such as Thaï (Siam), Anam, and one or two other cases, they are correctly formed on local cubic measure.

The very marked distinction between foreign measures of capacity that are truly cubic or otherwise is important; it has, however, not been preserved in the tables, all nominal measures of capacity being classified together for the sake of convenience in reference.

CUBIC INCHES, DECIMAL CUBIC INCHES, AND DECIMAL FLUID-OUNCES

GENERAL VALUES.	English Commercial Equivalent. Cub. inch	English Scientific Equivalent. Fluid-oz.	French Scientific Equivalent. Cent. cub.
English cubic inch duodecimal at 62° Fahr.	1	0·5782	16·3721
Scientific value of the same at 32° Fahr.	1·0009	0·5787	16·3862
Fluid-ounce of the English decimal measures, or the 1000th of the cubic foot at 32° Fahr. = 1000 fluid mils	1·7290	1	28·3153
Decimal cubic tum of Sweden	1·5980	0·9240	26·1629
Cubic inch of Prussia, Norway, and Denmark, duod.	1·0928	0·6319	17·8911
Cubic inch of Austro-Hungary	1·1162	0·6454	18·2749
Decimal kubikzoll of Austro-Hungary	1·9288	1·1153	31·5790
Cubic inch of Spain, duod.	0·7622	0·4407	12·4782
,, Portugal, duod.	1·2703	0·7345	20·7969
Cubic tsun of China (Board of Works) dec.	2·0547	1·1880	33·6391

FORMER, LOCAL, OR SPECIAL VALUES.

GERMANY:—			
Baden and Nassau, decimal and metric	1·6491	0·9535	27·0000
Bavaria, decimal	1·5185	0·8780	24·8611
,, duodecimal	0·8788	0·5081	14·3872
Brunswick, duod.	0·8213	0·4749	13·4468
Bremen, decimal (also the duod.)	1·4773	0·8542	24·1870
Gotha, duod.	0·8410	0·4863	13·7691
Hanover, duod.	0·8800	0·5088	14·4074
Hesse-Darmstadt, decimal and metric	0·9544	0·5518	15·6250
Hamburg, duod.	0·8312	0·4806	13·6077
Mecklenberg, duod.	0·8710	0·5036	14·2605
Oldenberg, duod.	0·9194	0·5322	15·0692
Saxony, Dresden duod.	0·8020	0·4638	13·1312
,, Leipzig duod.	0·7982	0·4615	13·0686
Würtemberg, decimal	1·4362	0·8304	23·5142
Swiss (Waadt) decimal and metric	1·6491	0·9535	27·0000
FRANCE:—			
Pouce cube (mesures usuelles) duod. and metric	1·3091	0·7570	21·431
Parisian pouce cube, duod.	1·2117	0·7006	19·8364
HOLLAND AND BELGIUM:—			
Amsterdam, kubieke duim (undec.)	1·0413	0·6021	17·0479
Brussels, kubieke duim (undec.)	0·9622	0·5563	15·7532

For other values, decimalise on the equivalents of the cubic feet.

CUBIC FEET.

GENERAL VALUES.	English Commercial Equivalent. Cub. ft.	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Déc. cub.
The cubic foot of England, America, and Russia, and their dependencies, duod. = 1728 cubic inches	1	0·9991	28·2909
The scientific value of the same at 32° Fahr. = 1000 decimal fluid-ounces, decimal	1·0009	1	28·3153
The cubic foot of Prussia, Norway, and Denmark	1·0928	1·0918	30·9158
The cubic foot of Sweden and Finland (formerly duod.), decimal	0·9248	0·9240	26·1629
The cubic foot of Austro-Hungary, dec. and duod.	1·1162	1·1153	31·5790
The cubic foot of Spain, duod.	0·7622	0·7615	21·5623
The cubic foot of Portugal, duod.	1·2703	1·2692	35·9370
The cubic foot of the Chinese Empire, decimal (the Board of Works' kambuchih)	1·1890	1·1879	33·6391

FORMER, LOCAL, OR SPECIAL CUBIC FEET.

GERMANY :—			
Prussian Rheinfuss	1·0928	1·0918	30·916
Anspach and Baireuth, duod.	0·9525	0·9517	26·946
Altona and Hamburg, ,,	0·8312	0·8304	23·514
Baden, metric, dec.	0·9544	0·9535	27
Bavaria, dec. and duod.	0·8788	0·8780	24·861
,, Werkschuh	0·9186	0·9178	25·987
Rhenish Bavaria, metric duod.	1·3091	1·3080	37·037
Bremen, dec. and duod.	0·8549	0·8542	24·187
Brunswick, duod.	0·8213	0·8206	23·236
Cöln and Aschaffenberg	0·8407	0·8400	23·764
Culm	0·8452	0·8445	23·913
Danzig, duod.	0·8348	0·8341	23·615
Elsass, Stadtschuh	0·8549	0·8542	24·188
,, Landschuh	0·9073	0·9065	25·672
Gotha, duod.	0·8410	0·8403	23·793
Halle	0·8498	0·8491	24·046
Hanover, duod.	0·8800	0·8792	24·896
Heiligenstadt and Erfurt	0·8020	0·8012	22·691

CUBIC FEET—*continued.*

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Cub. ft.	Cub. ft.	Déc. cub.
GERMANY—*continued* :—			
Hesse Darmstadt, metric dec.	0·5523	0·5518	15·625
,, Electoral, ordinary duod.	0·8418	0·8410	23·813
,, ,, landfuss	0·8174	0·8166	23·125
Holstein	0·9398	0·9389	26·584
Lippe-Detmold and Schaumberg	0·8576	0·8568	24·266
Lothringen	0·8266	0·8258	23·377
Lübeck and Rostock	0·8434	0·8426	23·863
Münster	0·8693	0·8685	24·591
Mecklenburg, duod.	0·8710	0·8703	24·642
Nassau, werkfuss, dec. and metric	0·9544	0·9535	27
Nuremburg, stadtfuss, duod.	0·9916	0·9907	28·055
,, artilleriefuss	0·7943	0·7935	25·192
Oldenburg, duod.	0·9204	0·9196	26·040
Saxe-Weimar, werkfuss, duod.	0·7927	0·7920	22·426
Saxony, Dresden, duod.	0·8020	0·8014	22·691
,, Leipzig, dec. and duod.	0·7982	0·7975	22·583
Silesia (Prussian)	0·8439	0·8431	23·876
Würtemberg, dec.	0·8312	0·8304	23·514
SWITZERLAND :—			
Berne and Freiberg, duod.	0·8914	0·8906	25·220
Basel, duod.	0·9985	0·9976	28·244
Saint Gall, duod.	1·0281	1·0272	29·087
Geneva	4·1063	4·1028	116·17
Glaris, Grisons, Uri, Waadt, Valais, Schwytz, duod.	0·9544	0·9535	27·000
Lucerne, ordinary duod.	1·0928	1·0919	30·916
,, joiners'	0·9916	0·9907	28·049
,, bauschuh	0·8116	0·8109	22·962
Neufchâtel, landfuss, duod.	0·8914	0·8906	25·220
Rheinfelden, Arau (Vienna)	1·1162	1·1153	31·579
Schaffhausen, werkschuh	0·9343	0·9335	26·432
Ticino, brazzetto	3·0296	3·0270	62·571
Zug, ordinary duod.	0·9544	0·9535	27·000
,, steinschuh	0·6857	0·6851	19·400
Zurich, dec. and duod.	0·9544	0·9535	27·000
,, bauschuh	0·9677	0·9669	27·007
FRANCE :—			
Pied du roi, Paris, duod.	1·2117	1·2106	34·277
Pied métrique, duod.	1·3091	1·3080	37·037
HOLLAND AND BELGIUM :—			
Amsterdam, undec.	0·8020	0·8014	22·691
Brussels, ,,	0·7411	0·7405	20·967

CUBIC FEET—*continued.*

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Cub. ft.	Cub. ft.	Déc. cub.
AUSTRO-HUNGARY :—			
Imperial, dec. and duod.	1·1162	1·1153	31·579
Bohemia	0·9203	0·9195	26·040
Galicia	0·9257	0·9249	26·188
Illyria, Trieste, duod.	1·1374	1·1364	32·179
Moravia	0·9166	0·9158	25·934
Poland, Cracow, duod.	1·6002	1·5988	45·270
Silesia	0·8568	0·8560	24·243
Tyrol	1·3182	1·3170	37·293
RUSSIA :—			
Imperial, duod.	1	0·9991	28·291
Lithuania, duod.	1·2116	1·2105	34·278
Revel, duod.	0·6649	0·6642	18·812
Riga, duod.	0·7278	0·7271	20·589
Pernau	0·7295	0·7288	20·638
Poland, Warsaw, duod.	0·8444	0·8437	23·888
ITALY :—			
Bergamo	2·9661	2·9635	83·913
Bologna, dec. of perch	1·9411	1·9394	54·915
Brescia	3·6933	3·6901	104·487
Cremona	3·9952	3·9918	113·029
Mantua	3·5977	3·5946	101·782
Milan	2·9135	2·9110	82·426
Modena	5·0581	5·0538	143·100
Padua and Vicenza	1·6137	1·6123	45·652
Parma	5·7113	5·7064	161·580
Piacenza (agrarian)	3·6675	3·6644	103·757
Piedmont, piede manuale (in 8ths)	1·4201	1·4189	40·177
,, piede liprando (in 12ths)	4·7944	4·7903	135·638
Reggio	5·2892	5·2847	149·637
Rome	0·9343	0·9334	26·437
Savoy, Chambéri	1·3819	1·3807	39·096
Venetia	1·4820	1·4807	41·927
Verona	1·4251	1·4239	40·318
SPAIN :—			
Castile, duod.	0·7622	0·7615	21·562
Aragon	0·5999	0·5993	16·975
Valencia	0·9768	0·9759	27·634
AMERICA :—			
Mexico, Buenos Ayres, and Montevideo, Chili, Peru, La Havana; old value of the Castilian cubic foot	0·7969	0·7961	22·545
Pernambuco	0·9925	0·9916	28·078
Quebec (pied du roi)	1·2117	1·2106	34·277

CUBIC YARDS, METRES, STAB, VARAS, &c.

GENERAL VALUES.	English Commercial Equivalent. Cub. yds.	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Mèt. cub
England and America cubic yard = 27 cubic feet; Indian cubic gaz = 8 cubic hāth	1	26·977	0·7639
Scientific value of the same at 32°	1·0009	27	0·7645
Mètre cube of France, Holland, Belgium, and Italy = 1000 déc. cub.	1·3091	35·317	1
Vara cubica of Spain = 27 piés cub.	0·7622	20·914	0·5822
Vara cubica of Portugal = $37\frac{1}{27}$ pés cub. = 125 palmos cubicos de craveira	1·7425	47·006	1·3310
FORMER LOCAL, OR SPECIAL VALUES.			
FRANCE :—			
Demitoise cube métrique (1812–1840)	1·3091	35·317	1
,, ancienne (till 1812)	1·2117	32·685	0·9255
Aune (stab) métrique cube (1812–1840)	1·8853	50·857	1·4400
,, ,, ancienne cube	2·1977	59·283	1·6786
SPAIN AND AMERICA :—			
Castile	0·7622	20·91	0·5822
Aragon	0·5999	16·19	0·4583
Barcelona	0·6120	16·50	0·4673
Galicia	1·6739	45·16	1·2786
Valencia	0·9765	26·35	0·7461
Mexico, La Plata, La Havana	0·7984	21·54	0·6098
Peru, Chili, and Manila	0·7971	21·50	0·6087
Canaries	0·7810	21·06	0·5963
Curaçao	0·7976	21·52	0·6092
Brazil	1·6815	45·36	1·2844
ITALY :—			
Tuscan pasetto cub. = 8 bracci cubichi = 64 palmi cub.	2·0806	56·13	1·5893
Carrara carrata = 25 palmi cubichi (a load used as a cubic measure for marble)	0·4736	12·80	0·3624

NOMINAL UNITS FOR SPECIAL PURPOSES.

UNITS OF WOOD-FUEL MEASURE.

GENERAL AND FORMER LOCAL VALUES.	English Commercial Equivalent. Cub. ft.	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Mèt. cub.
England, the stack, $1 \times 1 \times 4 = 4$ c. yards	108	107·91	3·0554
,, the cord, $4' \times 4' \times 8' = 128$ c. feet	128	127·89	3·6212
Denmark,[1] favn for fuel, $3 \times 3 \times 1 = 9$ cub. alen	78·68	78·61	2·2259
Sweden,[1] famn for fuel, $3 \times 3 \times 1\frac{1}{2} = 13\frac{1}{2}$ cub. åln	99·88	99·79	2·8256
Prussia, holzfaden, $3 \times 3 \times 1 = 9$ kub. ellen	118·02	117·92	3·3389
,, haufen, $18' \times 9' \times 3' = 486$ kub. f.	531·09	530·63	15·0251
Baden, holzklafter, $6' \times 6' \times 4' = 144$ c. f.	137·43	137·31	3·8880
Bavaria, holzklafter, $6' \times 6' \times 3\frac{1}{2}' = 126$ c. f.	110·73	110·63	3·1325
Bremen, holzfaden = 72 kub. fuss	61·56	61·50	1·7415
Brunswick, malter, $3\frac{1}{6}' \times 4' \times 4\frac{3}{4}' = 60\frac{1}{6}$ c. ft.	52·95	52·90	1·4979
,, klafter, $6\frac{1}{3}' \times 4' \times 4\frac{3}{4}' = 120\frac{1}{3}$ c. feet	105·89	105·80	2·9958
Breslau, holzstoss, $10 \times 5 \times 1\frac{1}{2} = 75$ c. ells	550·94	550·47	15·5867
Coblenz, holzfaden = 192 c. ft.	166·57	166·44	4·7127
Darmstadt, stecken, $4' \times 5' \times 5' = 100$ c. ft.	55·23	55·18	1·5625
Frankfurt, stecken, $3\frac{1}{2}' \times 3\frac{1}{2} \times 3'\frac{1}{2} = 42\frac{7}{8}$ c. ft.	34·94	34·91	0·9885
,, gilbert = 2 stecken = $85\frac{3}{4}$ c. ft.	69·88	69·82	1·9769
Gotha, charcoal malter, $3\frac{1}{2}' \times 3\frac{1}{2}' \times 3\frac{1}{2}' = 42\frac{7}{8}$ c. ft.	36·06	36·03	1·0201
Gotha, holzklafter, $6' \times 6' \times 3' = 108$ c. ft.	90·83	90·75	2·5696
Hamburg,[1] holzfaden, $6\frac{2}{3}' \times 6\frac{2}{3}' \times 2' = 88\frac{8}{9}$ c. ft.	73·88	73·82	2·0902
Holstein, holzfaden, $6' \times 6' \times 2' = 72$ c. ft.	59·84	59·79	1·6930
Nassau, holzklafter, $6' \times 6' \times 4' = 144$ c. ft.	137·43	137·31	3·8880
Mecklenburg, holzklafter, $7' \times 7' \times 2' = 98$ c. ft.	82·66	82·59	2·3386
Mainz, stecken, $4\frac{1}{3}' \times 4\frac{1}{3}' \times 3' = 56\frac{1}{3}$ c. ft.	47·32	47·28	1·3387
Saxony, Leipzig klafter, $6' \times 6' \times 3\frac{1}{2} = 126$ c. ft	100·58	100·49	2·8454
Saxony, schragen = 3 holzklafter = 378 c. feet	301·72	301·47	8·5362
Würtemberg, scheitholzklafter, $6' \times 6' \times 4' = 144$ c. ft.	119·68	119·58	3·3860
Würtemberg, the wanne for hay, $8' \times 8' \times 8' = 512$ c. ft.	425·55	425·19	12·0393
France and the Netherlands, the stère or wisse	35·35	35·32	1
France, voie de Paris, $4' \times 4' \times 3\frac{1}{2}' = 56$ c. ft.	67·85	67·79	1·9195
,, corde de porte, $8' \times 5' \times 3\frac{1}{2}' = 140$ c. ft.	169·62	169·48	4·7988
Swiss Berne holzklafter, $6' \times 5' \times 3\frac{1}{2}' = 105$ c. ft.	93·60	93·52	2·6481
Swiss Waadt moule, $5 \times 5 \times 5 = 125$ c. ft.	119·30	119·19	3·3750

[1] The true cubic fathom is also used for fuel.

FUEL-MEASURES—*continued.*

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Cub. ft.	Cub. ft.	Mèt. cub
Swiss Zurich holzklafter, 6 × 6 × 2 = 72 c. ft. Swiss Zurich torfklafter = 6 korben = 72 c. ft.	68·73	68·67	1·9445

UNITS OF TONNAGE BY BULK (FOR LIGHT MERCHANDISE).

England, ton = 40 c. ft.	40	39·97	1·1316
France, old ton = 42 c. ft. de Paris . . .	50·88	50·84	1·4396
Hamburg, ton = 40 c. ft.	33·25	33·22	0·9406
Portugal, ton = $57\frac{3}{4}$ c. ft.	73·36	3·30	2·0754

CUBIC FATHOMS AND CUBIC RODS.

GENERAL AND FORMER LOCAL UNITS.	English Commercial Equivalent. Cub. yds.	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Mèt. cub.
England, cubic fathom = 8 cubic yards = 216 cubic feet (not generally used) . .	8	215·8	6·1109
,, cubic rod of the decimal system at 32° = 1000 cubic feet	37·069	1000	28·3153
Sweden, cubic famn = 216 cubic feet . .	7·398	199·6	5·6512
Danish, Norwegian, and Prussian cubic favn = 216 cubic feet	8·742	235·8	6·6778
Prussian cubic berglachter = $296\frac{8}{27}$ c. ft. . .	11·979	323·5	9·1602
,, schachtruthe = 144 cubic feet . .	5·828	157·2	4·4519
,, feldsteinruthe = 120 cubic feet . .	4·857	131·0	3·7099
Leipzig, cubic klafter = 216 cubic feet . .	6·386	172·3	4·8778
,, cubic lachter = 343 cubic feet . .	10·140	273·6	7·7458
,, kubikruthe = 720 cubic feet . . .	21·286	574·2	16·2594
Frankfurt cubic klafter = 216 cubic feet . .	6·519	175·9	4·9797
,, kubikruthe (earth) = 288 c. ft. . .	8·692	234·5	6·6396
,, ,, (mason's) = 312 c. ft. .	9·417	254·0	7·1929
Baden, kubikruthe = 1000 cubic feet. . .	35·347	953·5	27
Darmstadt, kubikruthe = 1000 cubic feet . .	20·455	551·8	15·6250
Berne, kubikklafter = 512 cubic feet. . .	16·904	456·0	12·9127
Geneva, cubic toise = 512 cubic feet (Paris) .	22·975	619·8	17·5499
Freiberg, cubic werkklafter = 1000 cub. ft. .	33·017	890·7	25·2202
Lausanne, cubic toise = 1000 cubic feet . .	35·347	953·5	27
Neufchâtel, cubic toise = 1000 cubic feet . .	33·017	890·7	25·2202
Zurich, cubic klafter = 216 cubic feet . .	7·636	206·0	5·8330
France, toise cube métrique = 216 p. c. usuels .	10·473	282·5	8
,, ,, ancienne = 216 p. c. (Paris) .	9·693	261·5	7·4039
Russia, cubic sasheen = 343 cubic feet . .	12·704	342·7	9·7038
Austria, cubic klafter = 216 cubic feet . .	8·930	240·9	6·8210
Spain, braza or toesa cub. = 216 cubic ft. . .	6·097	167·3	4·6575
Portugal, braça or toesa cub. = 125 c. ft. . . .	5·881	158·6	4·4921

ORIENTAL AND EAST-ASIATIC CUBIC MEASURES.

It is very doubtful whether the cubes of linear units are generally employed as cubic measures.

N.B. These English and French values of cubic units are clipped or reduced from longer values that correspond exactly.

CHAPTER V.

MEASURES OF CAPACITY.

COMMERCIAL measures of capacity, as distinct from cubic measures before treated, have their origin under one or other of the three following forms of derivation :—

First. Some convenient vessel is adopted as suitable to measuring produce of various kinds, such as a cubical or cylindrical box for corn, or an earthenware or metal vessel for ale or wine ; and its dimensions are measured in the linear measure of the country. This rather haphazard mode is undoubtedly very primitive.

Second. A vessel is made to contain a certain amount of produce, wine, oil, water, rice, wheat, flour, or grain, so that when full its contents will counterbalance a certain number of specified weights in use. This method is slightly in advance of the former as regards care and accuracy.

Third. A vessel is made in accordance with the linear measures of the country, so as to form a definite and easily defined cubic measure, and is also arranged in accordance with the weights of the country, while the latter are adjusted to suit the cubic measures. This method is in advance of the other two, as it is a matter involving much care and skill to make a weight that shall exactly balance the contents of a filled

cubic measure. Such a plan therefore is usually only adopted at the reorganisation, reconstruction, or in the remodelling of a complete national system.

It may be noticed that measures of capacity are not by any means necessary to nations not largely employed in commerce, as almost everything may be bought or sold by weight; the exceptions being such things as cannot be conveniently weighed, and produce or merchandise that may be made to absorb a large amount of water without showing much subsequent trace of the operation.

Oil, corn, grain, and vegetable produce may be, and are in some places sold by weight, and so also may any liquid, beer, wine or spirits; but it is principally for the convenience of the trade in liquids that measures of capacity are at all desirable, and secondly only with the object of preventing the adulteration with water of absorbent goods and produce, such as coke, flour, and things of low specific gravity or of a loose nature.

In many Oriental countries measures of capacity are almost unknown, and even in some semi-Oriental countries the so-called measures of capacity are merely disguised measures of weight, and are termed and expressed in accordance with the weight of grain, oil, wine or water, they may hold. From these very marked habits it may be supposed that the Oriental has been long fully aware of the fact that a capacity-measure of grain is comparatively valueless, and may hold nearly a quarter more by filling it with force.

In some countries, where Oriental influences have left an Arab, Moorish, or a Turkish trace, these undeveloped measures of capacity are common; and show the unobliterated effect of the units as applied to various substances.

Similarly the Indian seer, or ser, of weight, passing into Ceylon, forms a measure of capacity, and its multiples the parrah and mercal follow the same process. The same thing occurs also in Maisur, and some parts of Southern India, the Carnatic, Madura, Madras, and Trichinopalli; where there were some real ancient measures of capacity, the colaga, bullah, and others, with which the ser weight and the kandi weight system was blended at some comparatively late epoch.

Most of the doubtful measures of this transition class are more conveniently and correctly treated as measures of weight, even when varying in value with the nature of the produce or merchandise; but it is the natural error of the Teuton to assume a measure of capacity to exist under circumstances where he himself would use one, though as a rule the contrary is more true in any land where transition-measures may exist. The correct test is to examine whether three or more such measures of various sorts of produce vary in moderately close accordance with the specific gravities; two cases may be accidental, and afford no basis of reasoning.

As regards true measures of capacity, although they afford the conveniences before mentioned, they yet have disadvantages of their own; the mode of placing or packing the goods or produce in a measure of capacity may affect the amount, to a very important extent, as much as 10 per cent., so also may shaking it; again, there is no resource against a moderately incorrect measure of capacity, while a false weight or a faulty balance is easily exposed in a moment by means of a correct weight, or by reversing the weight and the counterpoise; besides this, measures of capacity become unclean from use.

Whether measures of capacity are generally more convenient than those of weight, for any other commercial purpose than that of a rapid retail sale of liquids, and of compounding medicine, is hence a matter still open to some doubt, as very large quantities of liquids have necessarily to be gauged, very small quantities of liquids may be weighed, large quantities of dry merchandise have to be weighed in the majority of cases, and the same is the case with very small quantities generally.

The general tendency in England has been to revert to weight in preference to capacity, for a large number of things; and to entirely abolish neutral measures. The sack, the keel, and the chaldron, of coal-measure, were for a long time neutral measures, that is, nominal measures of capacity, controlled by stipulations regarding weight; the bushel of salt-measure was a nominal bushel controlled by weights legislated for various sorts of salt; the butter-measures were actual kilderkin and firkin casks under regulated weights for the contents; the soap-measures were very similar to the butter-measures in having regulated weight for kilderkin barrel and firkin filled casks. These things have now been long obsolete, and replaced by direct weight, but they serve to explain the transition-measures of other countries, though in the converse way, as in England the transition has been back to weight, while in semi-Oriental lands the transition was from weight to capacity.

ENGLISH UNITS

Measures of capacity have generally been treated in England as following two separate systems—one for liquids, the other for dry merchandise; but though there

may be some convenience in dealing with them in this manner, and thus taking one set at a time, there is no more necessity for such a separation than for the German double arrangement in linear measure of a werkfuss, and a feldfuss.

In any complete system of measures of capacity some will necessarily be more useful for dry produce, and some for liquids, while a certain number serve both purposes equally well ; also, the measures applicable to any single branch of trade may be very restricted and detached ; but this is not a sufficient reason for forming two distinct general categories. That we neither talk of a bushel of ale nor of a firkin of corn is simply due to custom and habit, for there is no special reason or necessity for the measure of capacity for ale being a firkin of 9 gallons, while that for corn is a bushel of 8 gallons ; in fact, the ale-firkin of Henry VIII. (Act 23 of 1531) was a bushel, for it was an 8-gallon measure ; and the ale-barrel was a coomb, being 32 gallons—an arrangement not by any means transient, but lasting for a century and a half, or until the time of Charles II. (Act 12 of 1660). The system of binary multiples and binary subdivision applies to liquids quite as conveniently as it does to dry produce, and there is no sufficient reason for adopting different methods for them ; we have hence receded in this respect from the advantages of the time of Henry VIII.

If at any time the 8-gallon firkin, containing a bushel of water, and the 32-gallon barrel, containing a coomb of water, be revived, there would not only be an accordance between wet and dry measures up to the barrel, but the barrel would then form a convenient unit for the upper or nominal measures above it, put these in

accordance both for wet and dry measures in the same way, and reduce the incongruities in the system.

At present the English wet and dry measures correspond only from the pint to the gallon; the fixed liquid measures extend from the minim to the butt of 108 gallons; and the fixed dry measures from the pint to the quarter of 64 gallons. Besides these there are variable nominal measures that differ with various sorts of produce; tuns, lasts, sacks, and other units.

The division into legal and nominal measures of the whole series, which is given in the chapter on Systems, does not admit of very exact separation, without a lengthy study of various Parliamentary Acts; but a more practical division may be otherwise effected. There are certain actual measures that are copies of national standard measures, made by scientific men in accordance with legal definition, and there are others, that are multiples of the foregoing, that do not admit of direct scientific verification, from their size being beyond the powers, means, and apparatus used for such purposes. Now, a standard capacity-measure cannot be sufficiently verified by simple linear measurement, but must, for exactitude, have its contents in water correctly weighed; and all such standard measures, as do not admit of this process may be termed nominal measures in a correct sense of the word. On referring to the Report of the Warden of the Standards for 1866 it is mentioned that no balance existing in the Department could weigh more than 56lbs. of water; also in 1859 a standard cubic foot-weight (of about 62·42454 lbs. at 39° Fahrenheit) was made, and declared to be 62·321lbs. at 62° Fahr. the English normal commercial temperature, instead of about 62·3548 lbs.; hence the probability is that this was not a

standard from direct construction and verification, but one of estimation. From the above facts it may be deduced that the half-bushel is the largest real measure in England, and all higher measures are estimated measures, while perhaps even the gallon may be the highest unit of scientific verification. The parsimony of the nation with regard to scientific men and matters is too notorious to require comment; gratuitous and voluntary contributions to scientific progress and improvement being alone received, with due regard for the delicate susceptibilities of the British tax-payer. Even the labours of restoring the lost national standards were works of scientific charity (for detail see page 82 of Chisholm, 'On the Science of Weighing and Measuring.' London, 1877).

The scientific determination of the larger English measures hence cannot be expected until scientific benevolence is again patronised; and in the meantime we do not know with much exactitude the weight of water contained in a cubic foot at the English normal temperature.

The measures of capacity of which standards exist are given in the following list:—

STANDARD ENGLISH MEASURES OF CAPACITY,

with their legal capacity and weight of water.

THE BINARY SERIES.

	Gallons.	Cubic inches.	Grains.
Bushel	8	2218·192	560 000
Half-bushel	4	1109·096	280 000
Peck	2	554·548	140 000
Gallon	1	277·274	70 000
Pottle	½	138·637	35 000
Quart	¼	69·318	17 500

STANDARD ENGLISH MEASURES OF CAPACITY—*continued.*

	Gallons.	Cubic inches.	Grains.
Pint	$\frac{1}{8}$	34·659	8 750
Half-pint	$\frac{1}{16}$	17·329	4 375
Gill	$\frac{1}{32}$	8·664	2 187·5
Half-gill	$\frac{1}{64}$	4·332	1 063·75
Quarter-gill	$\frac{1}{128}$	2·166	546·875
Bottle	$\frac{1}{6}$	46·211	11 666$\frac{2}{3}$
Half-bottle	$\frac{1}{12}$	23·105	5 833$\frac{1}{3}$

Other Measures.

Fluid-ounce measures of 4 oz., 2 oz., 1 oz., $\frac{1}{2}$ oz.

Sixteen liquid-grain measures from 7,000 grains down to 1 grain.

Seven cubic-inch measures from 10 cubic inches down to 0·1 cubic inch.

Three gas standards : 10 cubic feet, 5, and 1 cubic foot.

Also the following :

	LEGAL WEIGHT OF WATER IN CONTENTS.	LEGAL CAPACITY.
	Grains.	
10 cubic inches.	2524·58	...
5 ,,	1262·29	...
2 ,,	504·916	...
1 ,,	252·46	...
0·5 ,,	126·23	...
0·2 ,,	50·492	...
0·1 ,,	25·246	...
	Grains.	Cubic inches.
4 fluid-ounces.	1 750	6·932
2 ,,	875	3·466
1 ,,	437·5	1·733
$\frac{1}{2}$,,	218·75	0·866

	Grains.	Cubic inches.
10 liquid grains.	10	0·0396106
5 "	5	0·0198
3 "	3	0·01188
2 "	2	0·00792
1 "	1	0·00396

Besides measures between 10 and 7000 liquid-grains. And the cubic foot measure, 62·321 lbs. of water.

Such are the measures, their legal capacities, and weights of water they may contain, at the standard temperature of 62° Fahrenheit under a barometric pressure of thirty inches.

The basis of the tabulated series is the acceptance of the determination by Sir George Shuckburgh in 1798, that the cubic inch of water weighs 252·458 grains; a matter that will be further referred to in the chapter on measures of weight.

The highest legal measure in this series being the bushel, all higher measures may be treated as nominal, without entering into the Acts that regulate them.

It will be noticed that minim measures do not exist, and that a large set of liquid or fluid-grain measures do exist, in the series, which is taken from the Warden's Report for 1874–5, and the list given in Chisholm's work dated 1877. This seems to foreshadow the abolition of the minim, its entire replacement by the fluid-grain measure, and a thorough accordance between all measures of weight and capacity from the ounce and fluid-ounce downwards—a consummation much to be desired, though under a more convenient subdivision.

A matter that appears neglected in connection with this arrangement is the dram and fluid-dram; whether they are to be abolished in all their old forms, and no

measure between the fluid-ounce and the fluid-grain, nor between the ounce-weight and the grain-weight, is to exist, or whether some new arrangement is in prospect, seems still undecided. In the meantime the old fluid-dram, an eighth of the fluid-ounce, would be represented by 54·685 fluid-grains, the equivalent of 60 old minims.

The old subdivision of the fluid-ounce into 480 minims, making the fluid-dram exactly 60 minims, preserved the binary method.

THE NOMINAL MEASURES.

Among the upper and nominal liquid-measures, the barrel of 36 gallons is the principal unit. The half-barrel and the quarter-barrel are termed kilderkin for beer, or runlet for spirits, and firkin; and the rest are multiples, as far as real English measures extend; the hogshead being 1½ barrel, and the butt 3 barrels; the butt being the highest fixed nominal measure completing the English series, which is arranged to suit the measurement of ale and beer.

The nominal spirit-measures.—The Jamaica puncheon of rum or spirits is often treated as a fixed English measure of 84 gallons, though it holds no place in the national series, varies greatly in amount, from about 72 to nearly 108 gallons, and is a measure of foreign origin, possibly a double French poinçon. The tierce of brandy or spirits is also a measure of foreign origin, a Bordeaux tierçon, which was two-thirds of the barrique and held about 151 litres, or 34 gallons, although its former trade value in London was 42 old wine-gallons, or about 35 imperial gallons. The awm of spirits was either a German or a Dutch ahm, ohm, or aam; the Prussian

ahm is $30\frac{1}{4}$ gallons, the Dutch aam $33\frac{1}{2}$; the trade value of the awm in England is 30 gallons. The anker of spirits was apparently a Continental anker at one time, but as the latter seldom exceed $8\frac{1}{2}$ gallons, and the English trade anker is a reputed 10 gallon measure, the origin is doubtful.

The whole of these spirit-measures of foreign introduction appear perfectly unnecessary in the English system, and might be well abolished in favour of the barrel, the half-barrel or runlet, and the quarter-barrel as an anker, which could be recognised by legal enactment, and thus complete the system.

The nominal wine-measures.—The pipes, butts, and hogsheads of wine are not English measures, but imported measures received from other nations, varying greatly in value; their correct values will be found in the tables of equivalents of foreign measures at the end of the chapter, also in many cases their English reputed trade values.

FOREIGN MEASURES OF CAPACITY.

On reviewing the whole of the capacity-measures used in modern times in Europe, their variety in value is certainly very marked, and their origin is generally very obscure; whilst at the same time they present a general uniformity of object or intention.

Commencing with the smallest measures and going upwards, the absence of medical measures corresponding to minims and fluid-grains is notable, indicating that compounding is done entirely by weight; the sole exception to this appears to be the cubic centimètre of the metric system, which is the thousandth part of the

litre, and whose content of water weighs a gramme. In English equivalents the cubic centimètre is either 16·931 or 15·432 liquid grains, and its content in water weighs 15·432 grains. The multiples of the cubic centimètre up to the litre are simple numerical multiples, and can hardly be termed measures; thus there is no convenient measure in the system corresponding to the English fluid ounce, the corresponding value of which would be 28·4 cubic centimètres. The litre is 1·7614 pint, or 0·22018 gallon, and is therefore larger than the new English bottle-measure, $\frac{1}{6}$ of the gallon, ·16667 gallon or $1\frac{1}{3}$ pint.

Proceeding to the small commercial liquid-measures devised to meet convenience in the retail sale of liquids, ale, beer, wine, oil, and honey, there is a marked accordance among the whole of the quarts, pots, mass, and crushka of Northern Europe, and the boccale and bozze of Southern Europe; the quartas and quartillos of Spain deviate most from the general type, being submultiples of the azumbre, and of the arroba, or old Moorish or Arab units. The extended employment of the term quart with local modification over so large a part of Europe, including Poland, for a measure of about the same value, is also worthy of note; whether this has been a mere repetition of the old Roman term quartarius is doubtful, because the quartarius was a much smaller measure (less than half an English pint), being a quarter of the sextarius or Roman unit (*as*) of capacity. This contained $\frac{10}{6}$ of a Roman pound of water $= \frac{10}{6} \times \frac{5}{7}$, or about 1·2 English pounds, thus making the quartarius about a quarter of an English pint; while the quarts of Modern Europe are almost all near the English quart. Such quarts may, therefore, have been Gothic and Teutonic in

origin, or, if that were not the case, they present a very striking instance of the generalisation of a unit of measure based on natural requirement and convenience—the correct principle of formation.

The multiples of the quart, pot, mass, stof, and crushka of Northern Europe are binary; the general type being, 2 quarts or pots = 1 kanne or can; and 2 kannen = 1 stübchen or gallon—in strict analogy with the English measures; for the term pot is exclusively used in some parts of England, and the term *can* is also applied to two pots in the same way. In Southern Europe, or rather in Italy, the pinta was a measure of 2 boccali; but no measure of 4 boccali, or any liquid measure corresponding to the Teutonic stübchen and English gallon, exists otherwise than as a very exceptional case. There are seldom any Italian measures between the pinta and the barile or the brenta, an approximate runlet, kilderkin, or half-barrel in English terms; the exceptions occurring only when the local Italian barile either takes the place of the brenta or happens to be rather smaller.

Proceeding from the gallon to the nominal liquid-measures of capacity, the German and Scandinavian ahm or ohm of about 30 gallons seems the most marked unit of this class, and though local measures vary, its ordinary typical subdivision is into 2 eimers, 4 ankers, 20 viertel, or 40 stübchen. The ahm, therefore, corresponds to the English kilderkin, runlet, or half-barrel. In the present Italian measures the soma is a hectolitre, but in the former local Italian measures, the soma, the brenta, and the mastello of from 15 to 20 gallons, and the wine-barrel, barile, of about two-thirds that amount, were the measures corresponding to the runlet.

In Northern Europe the higher nominal liquid-mea-

sures of capacity are mostly multiples of the awm, and sometimes of the barrel (termed a tonne); the barrel being variable, between 20 and 40 gallons, its local values are given in the tables. The Swiss saum corresponds to the English barrel, it is sometimes 3 local awms, or 4 local eimer, but is almost invariably a measure equal to 100 mass; the exceptions being the saum of Basel and Wintherthur of 120 mass, of Schaffhausen and Saint Gall 128 mass, of Zürich 90 mass. The double system of stadtsaum and landsaum correspond to the stadtmass and landmass.

The oxhoft or hogshead is 1½ awm, the butt is 2 awm, and the fuder or tun is 6 awm. The fass or vat corresponds to the Jamaica puncheon, and is variable, sometimes being a multiple of the barrel (tonne) and sometimes having some simple ratio to the oxhoft or to the eimer; its values are therefore given in the tables. It must, however, be noticed that the term fass is frequently and unnecessarily applied to the German fuder, kufe, and stückfass, thus causing confusion.

In Southern Europe the butt and the pipe are sometimes different measures and sometimes identical, but they form the more important units, while the barrica, which slightly corresponds to the oxhoft or hogshead, is a mere term for either half a pipe or for half a butt, and the tonelada (or tun) is a term either for two pipes or for two butts. The values of the pipes and the butts of Southern Europe are given in the tables, and in some cases the accepted English trade-values corresponding to them. The general arrangement adopted in the tables of liquid-measures of capacity is this: a series of small measures approximating to the quart is first given; this is followed by a series of general values of measures

corresponding to the gallon, and another set corresponding to the runlet or kilderkin. The last set is a series of nominal measures from the barrel to the tun.

The Asiatic and African liquid measures of capacity given are very few in number, but it must be remembered that Eastern nations deal by weight generally, rarely use measures of capacity, and seldom have any; for the Oriental Moslem neither takes strong drink, nor consumes the midnight oil.

DRY-MEASURES OF CAPACITY.

MEASURES of this class are the most unsatisfactory of measures generally, from the fact that their use is or should be mostly confined to produce and goods of a loose nature, grain, coke, lime, fruit, vegetables, &c., and to those of an absorbent nature that may be easily tampered with and adulterated with water without leaving much trace of the operation. Such produce may often be so handled in measurement as to render the indicated amount entirely fallacious; the error possible being fully 25 per cent.; though in most cases it even amounts to 10 per cent. On the other hand, it is almost as unsatisfactory to weigh many such goods; for instance, coke, which will absorb more than one-third its original weight of water, without its being apparent, would be liable to an undiscoverable error of 33 per cent. Other things are not liable to such a high error from trusting to weight, and as a rule estimation by weight is preferable to measurement by capacity.

Under such circumstances any tabulated values of equivalents of foreign dry-measures of capacity are not

more useful from being extended to many figures, for they cannot be practically applicable with exactitude.

The range of dry-measures of capacity is necessarily very limited, from the reason that small quantities of dry produce are sold by weight, while very large quantities are either sold by weight or by nominal measures of capacity, loads and lasts that are mere arithmetic multiples of real measures.

In every well-regulated system of measures, the dry-measures are in conformity with the liquid-measures, and are convenient multiples and submultiples of them; but this cannot be said to be the case generally either in the old German measures or in the old Italian measures, where in some instances the accordance is very imperfect and badly arranged. In the old French measures the arrangement was worse. Such circumstances are the cause of and form the necessity for a reconstruction of the whole series, or a reason for the adoption of the metric system. In England, where a bushel is 8 gallons, and a quarter is 8 bushels, and the system is in this respect perfect and complete, any such change would not only be undesirable and unnecessary, but needlessly troublesome.

In Russia—where the vedro of liquid is 30 lbs. of water, the chtof, its eighth part, is $3\frac{3}{4}$ pounds, the tschetverik of dry-measure is 64 pounds[1] of water, and the tschetvert is 8 tschetverik—there is a relation which holds throughout the whole, which similarly renders the adoption of metric measures unnecessary and unadvisable. On the other hand, it does seem unfortunate that the binary system is not rigidly adhered to in the Russian

[1] The Russian pound (funt) is divided in a perfect binary scale into 96 sol, or 9216 dola; its value in English is 6319·81 grains.

system, which might be done either by making the tschetverik exactly equal to two vedro, or by making the vedro exactly half a tschetverik.

As to the range of dry-measures, it may be noticed the English gallon is comparatively large as a liquid-measure, while as a dry-measure it is a comparatively small one. In point of importance, the bushel of dry-measure is the principal unit of use, and the submultiples, the pecks, gallons, pottles, quarts, and pints are of less consequence, while the quarter of eight bushels is an important measure. Hence the extent of the more important English dry-measures is from the bushel to the quarter, higher measures being nominal measures, and smaller measures being treated as fractions of the bushel.

The tables of equivalents of foreign measures at the end of this chapter are arranged in accordance with this classification, and are divided into three classes : measures analogous to the bushel, those corresponding to the quarter, and nominal measures of higher value.

It might at the first glance appear preferable to arrange them in accordance with their names, and follow out types of measure based on nomenclature. Such an arrangement is possible in the tabulation of the liquid-measures, and is actually carried out, for the reason that the liquid-measures of Europe were found to follow certain types in a general and approximate way ; but among the dry-measures, where less parallelism exists, any such attempt would have caused confusion, and hence the English bushel and the English quarter were taken as types with which the tabulated measures were grouped, either as small or as large measures. The principal cases that led to this arrangement were, first, the metzen, some of which are small, being mere

subdivisions of the scheffel, and others very large, being even larger than many of the scheffel; and secondly, the scheffeln, some of which are comparatively small, and others being larger than an average malter. Also in Switzerland the values of the mass, the viertel, and the sester or setier, are similarly subversive of strict conformity of type to general value.

Following out the classification adopted, it may be noticed that the measures analogous to the English bushel, or small measures, are among the nations of Northern Europe termed scheffel, skieppe, schepel; the exceptionally large scheffel of Brunswick and that of Bavaria falling outside this class, and being approximate quarters. In Southern Germany and in certain provinces of Central Germany the scheffel is wanting, and its place, or rather its employment as an approximate bushel, is supplied by the simmer, sester, himt, and by a metze of large size; in Switzerland the viertel holds a generally corresponding position, although there is much diversity among Swiss measures. The Italian staja and stari were mostly rather small bushels; while the Spanish and Portuguese fanegas and fangas are very large bushels, mostly about a bushel and a half. The kiloz and bacile of Turkey and Greece, again, are rather small bushels; while in Asiatic and African countries true dry-measures are rare, as grain is most frequently sold by weight.

LARGE AND NOMINAL DRY-MEASURES.

The English nominal dry measures are multiples of the bushel in the same way as the nominal liquid measures are multiples of the barrel.

The quarter is a fixed measure of eight bushels, the half-quarter being called a coomb, and the half-coomb or two-bushel measure a strike—convenient terms less used now than in former times. The sack is unfortunately variable, its reputed values being for coke 3 bushels, for corn 4 bushels, and for flour 5 bushels; while the sack of coal is not a measure of capacity but a weight of two hundredweight; and the sack of wool is also a weight, being 364 lbs. The exclusive sale of corn and flour by weight would reduce the sack to a fixed single measure. The chaldron, used for coke alone, is 9 bushels—an unnecessary measure that might well be suppressed and superseded by the quarter of 8 bushels; while, if convenient, retaining the name of chaldron as applied to coke; similarly, also, the sack might either be entirely ignored as a measure of capacity, or fixed at 4 bushels for goods of all sorts.

Proceeding to the foreign measures, that approximate to the English quarter as regards value—that is, a measure of about 8 bushels, or 3 hectolitres of the metric system—it may be noticed that the English quarter is seldom closely represented anywhere; the Russian tschetvert being that most nearly corresponding. Anything more than roughly approximating to a general uniformity can hardly be expected in measures of this type; but the greater part of them appear to range between the half and the double of the English quarter, and it would not be conducive to clearness to subdivide them into separate sets.

The malters of Germany range between 3 and 8 bushels, excepting the unusually large Prussian malter; the large scheffel of Bavaria and that of Brunswick fall among these large measures. The droemt is a large

measure, analogous to the Prussian malter, and a few of the simmer and simra fall in this category, all the measures of which are rather larger than the English quarter.

The Austrian müth is an exceptional measure of large size. The Swiss mütt are smaller measures following a type of their own generally, but are very diverse in value ; hence the Swiss malters and Swiss sacks, that approximate more nearly to the English quarter, are given in preference to them in the tables ; from these, the values of the mütt may be reduced when required.

The old Italian moggio, rubbio, sacco, and soma, are very diverse ; so also are the Spanish cahiz and the Portuguese moio. The Levantine large measures show a similar diversity.

There is one dry-measure of capacity that is common to almost every nation that uses capacity-measures, and that is the sack ; the word sack is reputed to be one of the most widely spread terms in the vocabulary of the world, and accounted for by the theory of anxiety to secure luggage and effects on the disruption of races at the historic city of Babel. However this may be, the values of the grain-sack of various nations are exceedingly varied, the extreme limits being an English bushel and an English quarter—that is, the value is between one bushel and eight bushels ; most of them, however, lie between two and four bushels, thus affording sufficient grounds for theorising about a primitive or primæval sack. As a modern measure the sack is seldom worthy of consideration ; the cases in Italy and in Switzerland where its place is not supplied conveniently by some other measures are comparatively few.

The nominal measures of capacity are the load, the barrel, the cartload, and the last.

The load, or man's load, is usually a measure of about five English bushels, but does not admit of any fixity; the cartload is generally about 40 bushels, or five English quarters, and is similarly variable.

The barrel, or, as many nations term it, the tonne, of capacity, varies with the description of produce, and is also very variable as regards capacity; the only source of uniformity being the common custom of using old barrels intended for liquids, which have some approximate known capacity branded on the bung-stave.

The grain-last is frequently a multiple of the barrel, and, as it is often referred to in commercial transactions and shipping matters, it becomes a more important unit than the barrel; the values of the grain-lasts are given in the tables, and from these the contents of some grain-barrels may be reduced when required.

A great number of lasts of various sorts are mere numerical expressions, or customary terms for produce packed according to stereotyped habit and the requirements of trade, in barrels, bales, or collections of various forms; such lasts can seldom be considered measures of capacity, as the barrels are estimated by weight.

The English last of capacity varies from 10 to 12 quarters; the numerical last expressing a quantity is sometimes a multiple of any customary barrel; thus the last of herring or of cod consists of 12 barrels, the last of gunpowder 24 barrels, a last of soap 12 barrels, and of salt 18 barrels; the barrels being very various.

The following small collection of values of the foreign barrels as dry-measure is suited to the Baltic and Northern ports of Europe:—

NORWAY AND DENMARK.

	English gallons.	French litres.
For corn and lime.		
Barrel=$\frac{1}{22}$ last=144 krüge . .	30·60	138·97
For flour, soap, butter, tallow and meat.		
Barrel=136 krüge or pots . .	28·92	131·38
For fish, pitch and tar.		
Barrel=120 krüge	25·50	115·81
For coal.		
Barrel=$\frac{1}{18}$ last=176 krüge . .	37·70	169·85
For salt.		
Barrel=180 krüge or pots . .	38·55	173·71

SWEDEN AND FINLAND.

For corn.		
Augmented barrel=63 kannar .	36·29	164·81
For flour and fish.		
Augmented barrel=48 kannar .	27·65	125·57
For salt and lime.		
Augmented barrel=34 kappar .	34·27	155·65
For pitch and tar.		
Augmented barrel=95 stop . .	27·36	124·26
For malt.		
Augmented barrel=38 kappar .	38·31	173·97

The exceptional customary barrels in Finland are :—

For coal.		
Barrel of 56 kannar . . .	32·26	146·50
or the unaugmented Swedish corn-barrel.		

For salt.

The Finnish barrel is the Swedish augmented corn-barrel
The augmentation is a customary addition of one-eighth.

RUSSIA AND FINLAND.

For Finland, see as under Sweden.

The *Riga barrel* for dry merchandise is :—

For corn and flax, pitch and tar, fish and salt.		
Barrel=$\frac{1}{24}$th last=2 lof=12 kulmet	30·07	136·57

	English gallons.	French litres.
The *Revel barrels* for dry merchandise :—		
For corn, flax, hemp, and lime.		
Barrel=$\frac{1}{24}$th last=3 lof=9 kulmet .	26·05	118·30
For salt.		
Barrel=$\frac{1}{18}$th last=4 lof=12 kulmet	34·73	157·74
HOLLAND.		
The Nederlandsche vat or barrel of 100 kannen (metric)	22·02	100
NORTH GERMANY.		
Berlin barrels.		
For coal, salt, cement, lime, potash.		
Barrel=4 scheffel or $7\frac{1}{9}$ cubic feet .	48·41	219·85
For flax and hemp.		
Barrel=$37\frac{2}{3}$ metzen or 7232 cubic inches	28·49	129·39
Hamburg barrels.		
For corn and flax.		
The Danish corn-barrel . . .	30·60	138·97
For lime.		
Barrel=3 fass=6 himten . .	34·84	158·25
For coal.		
Barrel=$\frac{1}{12}$ last=$8\frac{1}{5}$ cubic feet .	42·46	192·82
For salt.		
Barrel=$\frac{1}{12}$ last=7 himten . .	40·65	184·62
Bremen.		
For coal.		
Barrel=$\frac{1}{12}$ last	42·45	192·82
For salt.		
Barrel=$\frac{1}{12}$ last=$3\frac{1}{3}$ scheffel . .	54·36	246·90
Lübeck.		
Corn-barrel=$\frac{1}{24}$ last=4 scheffel .	29·33	133·62

Much of the difficulty in connection with barrels is obviated in practice by the brand on the bung-stave, which gives, either in English or in French units, the reputed capacity or weight of contents of the barrel. Values of the last, a multiple of the barrel, are easily computed for cases other than those of grain; the grain-lasts alone are given in the tables following:—

As regards the future of the English capacity-measures, based on an old French pound of another system, it perhaps cannot be expected that they will exist unaltered much longer. As to substitutes for them, the English cubic foot and its multiples, whether decimal, binary, or both, are always available.

The strong attachment that a nation of copious drinkers has for its quarterns, pints, and quarts, militates against any change in retail or small liquid-measures, below the cubic foot; the wholesale liquid traders might object to change in casks and barrels; but in dry-measures above the cubic foot there seems a good opportunity for immediate change with a small amount of alteration, by adopting three units, the cubic foot, the quarter = 10 cubic feet, instead of 10·27 cubic feet; and the last = 100 cubic feet, instead of 102·7 cubic feet. These three units would answer all purposes in the upper part of the scale; while liquid-measures could serve for retail dealing. If required, a chaldron of 4 quarters might be also adopted. Anything more is evidently superfluous.

The same principle might also be similarly applied in liquid measures, with equal convenience and simplicity.

SMALL LIQUID MEASURES.

GENERAL VALUES.	English Commercial Equivalent. Quarts	English Scientific Equivalent. Fluid oz.	French Scientific Equivalent. Litres
England, imperial quart = 2 pints = 4 gills = 40 fluid ounces ; 2½ pounds of water at 62° Fahr.	1	40·10	1·135
Prussia, quart = 2 oesseln ; 64 cubic inches	1·008	40·44	1·145
Norway and Denmark, pott = 4 pœgel ; 54 cubic inches	0·851	34·12	0·966
Sweden, stop = 4 qwarter = 16 ort ; 50 cubic tum	1·152	46·20	1·308
Russia, crushka = 10 charki ; 3 pounds of water	1·082	43·40	1·229
Austria, mass = 2 kannen = 4 seideln	1·246	49·96	1·415
France, litre of the metric system ; 1 kilogram of water Holland, Nederlandsche kan = 10 maatje Italy, pinta = 10 coppi Poland, kwarti (metric) after 1819	0·881	35·32	1·000
Waadt and other Cantons, mass or pot = 10 glas (metric) ; 50 cubic inches ; (since 1823)	1·189	47·68	1·350
Spain, Castilian azumbre = 4 quartillos ; 154⅔ cubic inches = 16 copas	1·777	71·24	2·017
Portugal, Lisbon canhada = 4 quartillos	1·214	48·68	1·380

ORIENTAL COUNTRIES :—

Liquids are generally sold by weight ; for exceptions, see under local values.

FORMER LOCAL OR SPECIAL MEASURES.

GERMAN MASS, KANNE, QUART :—

Prussian quart of 64 cubic inches = 2 oesseln	1·008	40·44	1·145
Anspach, mass = 2 seideln = 4 schoppen	1·194	47·89	1·356
Altona, Hamburg, Lübeck, and Rostock ,, pot, or kanne = 2 quart = 4 oesseln	1·594	63·92	1·810
Baden, mass = 10 gläser	1·321	52·98	1·500
Bavaria, masskanne = 4 quarteln ; 43 decimal cubic inches	0·942	37·75	1·069
Bremen, quart = 2 oesseln	0·711	28·41	0·805
Brunswick, quart = 2 noesseln	0·809	32·46	0·919

SMALL LIQUID MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Quarts	Fluid oz.	Litres
Coblentz, biermass = 4 schoppen	1·515	60·75	1·720
,, weinmass	1·241	49·76	1·409
,, oelmass	1·126	45·03	1·275
Cöln, zapfmass	1·171	46·97	1·330
Dantzig, bierstof = 4 quarts	2·027	81·26	2·301
,, weinstof	1·511	60·60	1·716
Elsass, mass = 2 pintes	1·692	67·84	1·921
Erfurt, Thuringian kanne	1·648	66·08	1·871
Frankfurt, altmass	1·579	63·32	1·793
,, neumass	1·404	56·29	1·594
,, oelmass, of 1 pound of oil	0·456	18·29	0·518
Gotha, schenkmass = 2 noesseln	0·801	32·13	0·910
,, oelmass of 1 pound of oil	0·440	17·66	0·500
Hanover, quart = 2 noesseln; 2 pounds of spring water	0·856	34·33	0·972
Hesse Darmstadt, mass = 4 schoppen	1·761	70·63	2·000
Hesse (Electoral), weinmass = 4 schoppen; 144 cubic inches	1·747	70·07	1·984
Hesse (Electoral), biermass = $1\frac{1}{10}$ weinmass	1·922	77·06	2·182
Holstein, quart = 2 oesseln	0·797	31·96	0·905
Lippe-Detmold, visirkanne = 4 ort	1·212	48·60	1·376
Mainz and Nassau, kleinemass = 4 schoppen	1·493	59·86	1·695
Mainz and Nassau, grossemass, for beer and oil	1·661	66·61	1·886
Oldenburg, weinkanne = 4 ort	1·293	51·85	1·468
,, bierkanne = $1\frac{7}{13}$ quart	1·206	48·35	1·369
Saxe-Coburg, bier mass	0·840	33·69	0·954
Saxe-Weimar, schenkmass = 2 noesseln	0·807	32·35	0·916
Saxony, visirkanne	1·237	49·60	1·404
Würtemberg, hellaichmass = 4 schoppen	1·618	64·88	1·837
Würtemberg, trübaichmass = ,,	1·688	67·70	1·917
Würtemberg, schenkmass = ,,	1·471	58·98	1·670
SWITZERLAND:—			
Arau, mass	1·268	50·86	1·440
Berne, mass = 4 vierteln	1·472	59·01	1·671
Basel, altmass = 4 schoppen	1·252	50·22	1·422
,, neumass = ,,	1·002	40·19	1·138
,, oelmass = ,,	1·370	54·95	1·556
Freiberg, mass = ,,	1·376	55·17	1·562
Geneva, pot of 48 Parisian cubic inches	0·838	33·62	0·952
Glaris, mass = 4 stotzen	1·567	62·83	1·779
Grisons, mass = 4 quärtlein	1·170	46·94	1·329
Lucerne, mass = 4 schoppen	1·522	61·03	1·728
Neufchâtel, pot of 96 Parisian cubic inches	1·677	67·24	1·904
Schaffhaus, mass	1·158	46·44	1·315

SMALL LIQUID MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
SWITZERLAND—*continued.*	Quarts	Fluid oz.	Litres
Ticino, boccale	0·591	23·70	0·671
Saint Gall, mass = $1\frac{1}{8}$ schenkmass	1·155	46·34	1·312
Thurgau, mass	1·407	56·40	1·597
Uri, mass = 2 quärtli	1·598	64·10	1·815
Waadt, mass = 10 glas; 50 cubic inches	1·189	47·68	1·350
Zurich, lautermass = 2 quärtli = 4 stätzen	1·607	64·45	1·825
,, stadtmass = ,, ,,	1·446	57·99	1·642
,, oelmass, 88 cubic inches	1·211	48·56	1·375
FRANCE :—			
Parisian pot = 2 pintes = 4 chopines; 93·9 cubic inches (Parisian)	1·640	65·78	1·863
HOLLAND AND BELGIUM :—			
Amsterdam, mengel = 2 pinten	1·068	42·82	1·213
Brussels, wine pot = ,, ; 64 ounces	1·193	47·83	1·354
,, beer pot = ,,	1·145	45·92	1·300
AUSTRIA :—			
Imperial mass = 2 kannen = 4 seideln	1·246	49·96	1·415
Hungarian halbe or icze = 2 seitel or messli	0·735	29·45	0·834
Bohemian and Moravian mass	0·942	37·75	1·060
Poland, Cracow kwarti = $\frac{1}{4}$ garniec	0·835	33·48	0·948
Silesia, quart	0·618	24·79	0·702
Trieste, boccale = Vienermass	1·246	49·96	1·415
Tyrol, mass	0·712	28·57	0·809
RUSSIA :—			
Imperial crushka = 10 charki	1·082	43·40	1·229
Pernau and Narva, stof = 4 quarts	1·135	45·52	1·289
Revel, common stof = 4 quarts	1·048	42·03	1·190
,, stof for oil; $2\frac{1}{2}$ pounds	0·942	36·16	1·024
Riga, stof	1·063	42·63	1·207
Warsaw, kwarti = $\frac{1}{4}$ garniec	0·881	35·32	1·000
,, old kwarti = $\frac{1}{4}$ garniec; before 1819	0·835	33·48	0·948
ITALY :—			
The pinta of Lombardo-Venetia and Sardinia	0·881	35·32	1
Ancona, boccale = 4 fogliette	1·577	63·22	1·790
Bologna, ,, ,, 20 ounces of wine	1·083	43·44	1·230
Bergamo, pinta	1·217	48·81	1·382
Brescia, boccale = $\frac{1}{2}$ pinta	0·607	24·33	0·689
Ferrara, ,,	1·220	48·91	1·385
Milan, ,,	0·693	27·79	0·787

SMALL LIQUID MEASURES—*continued.*

	English Commercial Equivalent. Quarts	English Scientific Equivalent. Fluid oz.	French Scientific Equivalent. Litres
ITALY—*continued* :—			
Modena, boccale = ½ pinta	0·917	36·77	1·041
,, fiasco = 2 boccale	1·834	73·53	2·082
Padua and Vicenza, bozza	0·872	34·96	0·990
Piedmont, boccale = 2 quartini	0·603	24·19	0·685
Rome, boccale of wine	1·606	64·38	1·823
,, ,, oil	1·808	72·51	2·053
Rovigo, bozza	0·854	34·26	0·970
Trevisa, boccale di campagna	1·909	76·53	2·167
,, town boccale	1·431	57·39	1·625
Tuscany, wine ,, = 2 mezzette	1·004	40·24	1·139
,, oil ,, = 4 quartucci	0·920	36·89	1·045
,, fiasco = 2 boccale, wine	2·007	80·49	2·279
Venice, boccale = 1½ quartuccio	0·891	35·74	1·012
,, bozza = 4 quartucci	2·378	95·35	2·700
Verona, inghistara	0·862	34·58	0·979
Vicenza, inghistara	0·836	33·52	0·949
Naples, caraffa	0·640	25·68	0·727
,, quarto = 6 misurelle	0·557	22·36	0·633
Sardinia, quartana = 12 quartucci	3·699	148·33	4·200
Calabria, pignatolo	0·895	35·88	1·016
SPAIN AND PORTUGAL :—			
Spain generally azumbre = 4 quartillos	1·777	71·24	2·017
Alicante, quarto = 4 quartillos	2·543	101·99	2·888
Asturias, azumbre = 4 quartillos	1·983	79·50	2·251
Barcelona, quarto = 4 quartas	0·907	36·38	1·030
Valencia, azumbre = 2 medios	2·595	104·04	2·946
Galicia, ,, = 4 quartillos	2·044	81·97	2·321
Malaga, ,, = 4 ,,	1·745	69·96	1·981
Majorca, quarta (varies much)	0·919	36·87	1·044
Minorca, quartillo	5·049	202·47	5·733
Lisbon, canhada = 4 quartillos	1·214	48·68	1·380
Oporto, ,,	1·841	73·81	2·090
Bahia ,,	6·244	250·39	7·090
Brazil, medida = 2 canhadas = 4 garrafas	2·447	98·11	2·778
Colombo, canada = 2 quarts – 92⅘ c. in.	1·330	53·33	1·510
GREECE :—			
Cephalonia, boccale = 2 quartucci	0·833	33·42	0·947
Patras and Morea, wine boccale	1·880	75·42	2·135
,, ,, oil ,,	1·606	64·38	1·823
Thiaki, boccale = 2 quartucci	0·938	37·60	1·065
ARABIA :—			
Mokha, nasfiah = 16 vakia	0·83	33·41	0·946

SMALL LIQUID MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
ABYSSINIA :—	Quarts	Fluid oz.	Litres
Cuba, for honey = 62 English cubic inches . .	0·894	35·85	1·015
ORIENTAL COUNTRIES, INCLUDING NORTHERN INDIA :—			
Liquids are sold by weight.			
SOUTHERN INDIA :—			
Madras, measure = 8 olluck = 100 cubic inches, English	1·442	57·82	1·637
Cochin, oil measure	0·625	25·05	0·710
Madura, ,, ...	1·578	63·28	1·792
Masulipatam, manika	2·083	83·54	2·365
Negapatam, oil measure	1	40·08	1·135
Trichinopalli ,, ...	0·516	20·68	0·585
CEYLON :—			
Colombo, measure or ser of capacity = 65 cubic inches, English	0·938	37·58	1·064
THAÏ (OR SIAM) :—			
Thanan = 100 cubic niu	0·834	33·46	0·947
SUMATRA :—			
Pakha	0·484	19·42	0·550
CHINA :—			
Liquids are sold by weight; tching measure also exists, corresponding to the tching weight .	0·615	24·72	0·700
JAPAN :—			
Shöo = 10 göo	1·598	64·07	1·814

INTERMEDIATE LIQUID MEASURES.

GENERAL VALUES.	English Commercial Equivalent. Gallons	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Litres
England: the imperial gallon of 10 pounds of water at 62° Fahr. = 4 quarts = 6 bottles = 160 fluid ounces	1	0·1604	4·5417
Germany: Prussian stübchen = 4 quarts or mass; 256 cubic inches	1·0084	0·1617	4·5800
Norway and Denmark: stübchen = $3\frac{7}{8}$ pots	0·8243	0·1322	3·7437
Sweden: double kanna = 2 kanna = 4 stop; $\frac{1}{8}$ of a cubic foot of water, or 200 cubic tomme	1·1521	0·1847	5·2326
Russia: vedro = 10 crushka; 30 pounds of water	2·7057	0·4340	12·2884
Austria: viertel = 10 ordinary mass	3·1149	0·4996	14·1473
Italy: the soma = 10 pinte (metric)	2·2018	0·3532	10
Waadt: the broc of 500 cubic inches = 10 pots or mass = 100 glas	2·9724	0·4768	13·5
Spain: the wine arroba = 4 quartillas = 8 azumbres (Castile)	3·5531	0·5699	16·1370
Spain: the oil arroba = 4 quartillas = 100 panillas (Castile)	2·7663	0·4437	12·5640
Portugal: the almude of Lisbon = 2 alqueiras = 12 canhadas	3·6418	0·5841	16·5400
Turkey: alma or meter; 8 oka of oil	1·1531	0·1849	5·2368
Oriental liquid measures are few and local (see Local Units).			

FORMER, LOCAL, OR SPECIAL VALUES.

GERMANY:—

Prussian stübchen = 4 quarts or mass	1·0084	0·1617	4·580
,, ,, = 3 quarts	0·7563	0·1213	3·435
Bremen ,, = 4 ,,	0·7110	0·1136	3·218
Brunswick ,, = 4 ,,	0·8094	0·1298	3 676
Gotha ,, = 4 schenkmass	0·8012	0·1285	3·639
Hamburg, Holstein, and Lübeck, stübchen = 4 quarts	0·7971	0·1278	3·620
Hanover, stübchen = 4 quarts	0·8561	0·1373	3·888

INTERMEDIATE LIQUID MEASURES—*continued.*

	English Commercial Equivalent. Gallons	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Litres
GERMANY :—			
Altona,[1] Rostock, Lübeck, and Bremen, viertel = 9 quarts	1·5941	0·2557	7·240
Coblenz, viertel = 4 mass	1·2409	0·1990	5·636
Cöln ,, = 4 ,,	1·1711	0·1878	5·319
Frankfurt[1] ,, = 4 altemass	1·5789	0·2533	7·171
Hamburg[1] ,, = 8 quarts	1·5941	0·2557	7·240
Hanover ,, = 8 ,,	1·7122	0·2746	7·776
Hesse-Darmstadt,[1] viertel = 4 mass	1·7614	0·2825	8·000
Kürhesse,[1] viertel = 4 mass	1·7471	0·2802	7·935
Lippe-Detmold,[1] viertel = $5\frac{2}{8}$ kannen	1·6362	0·2625	7·431
Mainz,[1] wine and spirit viertel = 4 mass	1·4924	0·2394	6·778
,, beer and oil ,, = 4 ,,	1·6608	0·2664	7·543
Baden, stutz = 10 mass	3·3027	0·5297	15
Würtemberg, imi = 10 helleichmass	4·0447	0·6488	18·371
FRANCE :—			
Velte = 4 quarts = 8 pints (Paris)	1·6405	0·2631	7·45
,, (mesures usuelles) = 10 litres (1812–1840)	2·2018	0·3532	10
Corsica, zucca = 9 boccali	2·5695	0·4122	11·67
AUSTRIA :—			
Viertel = 10 mass (imperial)	3·1149	0·4996	14·147
Cracow (old), garniec = 4 kwarti	0·8351	0·1339	3·793
Illyria, Trieste, caffiso	2·6290	0·4217	11·94
RUSSIA :—			
Vedro = 10 crushki = 30 pounds of water	2·7057	0·4340	12·288
Warsaw, old garniec = 4 kwarti	0·8351	0·1339	3·793
,, metric garniec = 4 kwarti	0·8807	0·2595	4·000
HOLLAND AND BELGIUM :—			
Amsterdam, viertel = $3\frac{1}{21}$ stoopen	1·6271	0·2610	7·390
Brussels, schreef = 2 geltes = 4 pots	1·193	0·1913	5·418
SPAIN AND PORTUGAL :—			
Castilian wine arroba = 8 azumbres	3·554	0·5699	16·14
,, oil ,, of $27\frac{1}{4}$ lbs. of water	2·766	0·4437	12·56
Aragon, cantaro, or wine arroba = 8 azumbres	2·281	0·3655	10·36
,, oil arroba of 36 pounds	2·983	0·4786	13·55
Barcelona, cortan, or wine arroba = 6 mitadellas	2·270	0·3641	10·31
Malaga, cantara (wine) = 8 azumbres	3·490	0·5598	15·85
Valencia, cantaro (wine) = 4 azumbres } ,, oil arroba of 30 pounds }	2·528	0·4055	11·48

[1] At these places 20 vierteln = 1 ahm.

INTERMEDIATE LIQUID MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent	French Scientific Equivalent.
SPAIN AND PORTUGAL—*continued* :—	Gallons	Cub. ft.	Litres
Canary I., arroba of $4\frac{1}{4}$ old English wine gallons	3·541	0·5680	16·082
Gibraltar, arroba of $3\frac{1}{5}$ old English wine gallons	2·666	0·4276	12·108
Majorca, oil cortan of 9 rottoli	0·890	0·1428	4·043
Minorca, gerra = 2 cortes	2·655	0·4259	12·06
La Havana, arroba of $4\frac{1}{10}$ old English wine gals.	3·416	0·5479	15·514
Valparaiso, arroba of $8\frac{1}{4}$ English imperial gallons	8·250	1·3233	37·469
Mexico, jame = 18 quartillos	1·761	0·2825	8·00
Lisbon, almude = 2 alqueiras = 12 canhadas	3·642	0·5841	16·54
Oporto ,, = 2 ,, = 12 ,,	5·522	0·8957	25·08
Madeira almude	3·902	0·6258	17·72
Brazil ,, = 2 cantaros = 12 canhadas	3·642	0·5841	16·54
ITALY :—			
Florence, fiasco = 2 boccali	0·502	0·0805	2·279
,, fiasco (oil) = 2 ,,	0·459	0·0738	2·089
Ferrara, secchio = 5 ,,	1·524	0·2444	6·92
Venice ,, = $10\frac{2}{5}$,,	2·378	0·3814	10·80
Vicenza ,, = 10 bozze o inghistare	2·089	0·3352	9·49
Milan, bassa = 6 boccali	1·039	0·1667	4·72
Verona ,, = $4\frac{1}{2}$ inghistare	0·971	0·1558	4·41
Rome, cugnatella = $4\frac{1}{2}$ boccali (oil)	1·808	0·2899	8·21
Messina, caffiso of $12\frac{1}{2}$ rottoli grossi (oil)	2·576	0·4132	11·70
Calabria, stajo = 30 pignatoli	6·709	1·0761	30·47
Milan ,, = 32 boccali	5·544	0·8893	25·18
Naples, staro = 20 pignate = 16 quarti	2·228	0·3574	10·12
Sardinia, misura of oil	2·114	0·3390	9·60
Malta, caffiso (oil), $5\frac{1}{2}$ English wine gallons	4·582	0·7349	20·810
Ionian I., jaro of wine or oil = 4 mittre	3·750	0·6015	17·032
,, secchio = 12 boccali	2·500	0·4010	11·354
Zante and Cephalonia, lira o pagliazza	1·666	0·2674	7·570
ARABIA, ALGIERS, MOROCCO[1] :—			
Mokha, gadda = 8 nasfiah	1·666	0·2673	7·567
Algiers, khulleh or khull	3·523	0·5297	16·00
,, metal of oil of 20 rotal kébir	3·941	0·6322	17·90
Tripoli ,, 42 rottal	5·139	0·8243	23·34
,, harbaia = 6 caraffa, $18\frac{3}{4}$ rottal	2·294	0·3680	10·42
,, ,, of pommade $20\frac{1}{4}$,, unknown spec. grav.			
Tunis, wine matar	2·068	0·3477	9·845
,, oil ,, = 2 wine matar	4·335	0·6954	19·690
Soussa, oil matal	5·284	0·8476	24

[1] In Oriental countries, including Northern India, liquids are generally sold by weight; and large liquid measures do not exist.

INTERMEDIATE LIQUID MEASURES—*continued.*	English Commercial Equivalent. Gallons	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Litres
SOUTHERN INDIA :—			
The markal of 12 pakka ser weight.			
Madras, markal = 8 measures (oil) . . .	2·8839	0·4626	13·098
Madura ,, = 6 ,, ,, . . .	2·3672	0·3797	10·751
Masulipatam, markal = 6 manika (oil) . .	3·1250	0·5012	14·193
Negapatam ,, = 4 measures ,, . .	1	0·1604	4·542
Trichinopalli ,, = 4 ,, ,, . .	0·516	0·0827	2·340
CEYLON :—			
Colombo, markal, 780 c. in. = 12 measures, or seers of capacity	2·813	0·4511	12·770
THAI (OR SIAM) :—			
Thangsat = 20 thanan	4·1722	0·6692	18·949
SUMATRA :—			
Sukat = 12 pakha	1·453	0·2331	6·598
CHINA :—			
Liquids are sold by weight.			
Also, teu = 10 tching measures . . .	1·541	0·2472	7·000
JAPAN :—			
Liquids are sold by weight.			
Also, To = 10 shöo = 100 göo	3·9938	0·6407	18·141

LARGE LIQUID MEASURES.

GENERAL VALUES.	English Commercial Equivalent. Gallon	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent Litres
England : runlet or kilderkin = 18 imperial gallons ; or 180 pounds of water at 62° Fahr. = 2 firkins = 72 quarts = 2880 fluid ounces .	18	2·887	81·751
Prussian eimer = 2 anker = 60 quarts ; or 3840 cubic inches	15·126	2·426	68·700
Sweden : eimer = 2 ankar = 30 kannen = 60 stop ; or 3 cubic feet	17·282	2·772	78·489
Norway and Denmark : anker = 5 viertel = 10 stübchen = 19½ kannen = 39 pots . . .	8·243	1·322	37·437
Russia : anker = 2 stekar = 3 vedro = 30 crushki ; or 90 pounds of water	8·117	1·302	36·865
Austria : eimer = 4 viertel = 40 mass . .	12·460	1·999	59·589
France : hectolitre of 100 kilogrammes of water .			
Italy ; soma = 10 mina = 100 pinte . . .			
Holland : vat = 100 kannen	22·018	3·532	100
Polish beczka = 25 garniec = 100 kwarti . .			
Greece : koilon = 100 litra			

FORMER, LOCAL, OR SPECIAL VALUES.

GERMANY :—

Anspach, eimer = 66 mass	19·700	3·160	89·47
Altona, Hamburg, Lübeck, and Rostock, eimer = 4 viertel = 8 stübchen	6·377	1·023	28·96
Bavaria, schankeimer = 60 masskannen . .	14·123	2·265	64·14
,, visireimer = 64 ,, . .	15·064	2.416	68·42
Brunswick, anker = 10 stübchen . . .	8·094	1·2[illegible]8	36·76
Erfurt, Thuringian eimer = 2 anker = 36 kannen	14·830	2·379	67·36
Gotha, eimer = 40 kannen = 80 mass . .	16·025	2·5[illegible]0	72·78
Hanover, eimer = 32 kannen = 64 quarts . .	13·785	2·197	62·21
Lippe-Detmold, anker = 5 viertel . . .	8·182	1·312	37·16
Oldenberg, anker = 26 kannen = 40 quarts .	8·403	1·348	38·16
Dresden, eimer = 2 anker = 48 visirkannen .	14·842	2·381	67·41
Leipzig, eimer = 2 anker = 54 visirkannen .	16·698	2·678	75·84
Weimar, eimer = 72 kannen = 80 schenkmass .	16·139	2·589	73·30
Würtemberg eimer is the ohm = 16 imi (see p 172)			

LARGE LIQUID MEASURES—*continued.*

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Gallons	Cub. ft.	Litres
SWITZERLAND :—			
Berne, eimer or brenter = 25 mass	9·199	1·476	41·78
Basel, ahm = 8 viertel = 32 altemass	10·018	1·607	45·50
Arau, brenta = 25 mass	14·719	2·361	66·85
Freiburg, brenter = 25 mass	8·598	1·379	39·05
Geneva, setier = 24 quarterons = 48 pots	10·062	1·614	45·70
Glaris, eimer = 4 viertel = 30 kopf = 60 mass	23·506	3·770	106·76
Saint Gall, eimer = 4 viertel = 32 mass	9·245	1·483	41·99
Lucerne ,, = 30 mass or pots	11·415	1·831	51·84
Neufchâtel, setier = 2 brochets = 16 pots	6·709	1·076	30·47
Schaffhaus, eimer = 4 viertel = 32 mass	9·263	1·486	42·07
Thurgau ,, = 32 mass	11·251	1·805	51·10
Uri ,, of 60 ,,	23·978	3·846	108·90
,, ,, of 64 ,,	25·576	4·102	116·16
Waadt, setier = 3 brocs = 30 pots	8·917	1·430	40·50
Zurich, eimer stadtmass = 4 viertel = 60 mass	21·699	3·481	98·55
Ticino, brenta = 66 boccale	9·758	1·565	44·32
HOLLAND :—			
Amsterdam, anker = 2 steekkannen = 16 stoopen	8·543	1·370	38·80
AUSTRIA :—			
Eimer = 4 viertel = 40 mass	12·460	1·999	56·59
Hungary, Presburg and Pesth eimer = 64 icze	11·744	1·884	53·34
Hungary, Tokay antal = 88 icze = 176 messli	16·152	2·591	73·35
Bohemia, Prague eimer = 32 pints = 128 seidel	13·452	2·158	61·10
,, Temeswar kis-czeber = 50 icze	9·176	1·472	41·68
Illyria, Trieste orna = 40 boccale	12·460	1·999	56·59
Tyrol, üren, or yuren = 128 zimment	9·782	1·569	44·43
For SOUTHERN EUROPE see Barrels and Loads.			
RUSSIA :—			
Anker = 2 stekar = 3 vedro = 40 bottles	8·117	1·302	36·87
Narva and Pernau, anker = 30 stof	8·517	1·366	38·68
Revel, anker = 5 viertel = 30 stof	7·863	1·261	35·71
Riga ,, = 5 ,, = 30 ,,	7·971	1·278	36·20
SUMATRA :—			
Tub = 10 sukat = 120 pakha	14·530	2·331	65·98
CHINA :—			
Tche = 10 teu = 100 tching	15·412	2·472	70·00

NOMINAL LIQUID MEASURES.

BARRELS. *Tonne, fässchen, barile, barril, brenta, &c.*	English Commercial Equivalent. Gallons	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Hectol.
England: beer and ale barrel = 4 firkins . .	36	5·775	1·6350
Norway and Denmark : toende = 136 pots .	28·930	4·640	1·3139
Sweden and Finland : tunna = 96 stop . .	27·650	4·439	1·2558
GERMANY :—			
Berlin, tonne = 100 quarts, or 6400 cub. in. .	25·211	4·044	1·1450
Bremen ,, = 48 stübchen	34·009	5·455	1·5446
,, oil tonne = Berlin tonne . . .	25·211	4·044	1·1450
Brunswick tonne = 27 stübchen	21·855	3·506	0·9926
Gotha ,, = 24 ,, ...	19·228	3·084	0·8733
,, brandy tonne = 110 kannen	44·065	7·068	2·0013
Hanover, tonne = 26 stübchen	22·258	3·570	1·0109
Holstein, Hamburg and Rostock tonne = 32 stübchen ; (also one of 48 stübchen) . .	25·506	4·091	1·1584
Lübeck, tonne = 42 stübchen	33·478	5·370	1·5205
Saxony, Dresden tonne = 70 visirkannen . .	21·646	3·472	0·9831
,, Leipzig ,, = 75 kannen . . .	19·878	3·188	0·9028
Oldenburg, tonne = 112 kannen	33·754	5·414	1·5330
FRANCE :—			
Tonne de bière (mesure usuelle) = $7\frac{1}{2}$ veltes (1812–1840)	16·514	2·649	0·7500
AUSTRIA :—			
Tonne = 2 imperial eimer = 80 mass . . .	24·920	3·997	1·1318
Vienna, old tonne = 2 eimer = 85 mass . .	26·481	4·248	1·2027
Temeswar, nagy-cseber = 2 kis-cseber . .	18·352	2·944	0·8335
Cracow, old beczka = 36 garniec	30·063	4·822	1·3654
RUSSIA :—			
Narva and Pernau, tonne = 128 stof . . .	36·339	5·829	1·6504
Revel, tonne = 128 stof	33·542	5·380	1·5234
Riga ,, = 90 ,, ...	23·912	3·835	1·0860
,, brandy tonne = 120 stof	31·882	5·114	1·4480
Warsaw, old beczka = 36 garniec before 1819 .	30·063	4·822	1·3654
Lemberg, old beczka = 36 garniec ,, . .	30·471	4·888	1·3839

The above barrels are for liquids generally, except when otherwise specified, as for Bremen, Gotha, Riga.

NOMINAL LIQUID MEASURES—*continued.*

Wine barrels and oil barrels.	English Commerci Equivalent.	English Scientific Equivalent.	French Sci-ntific Equivalent.
SPAIN :—	Gallons	Cub. ft.	Hectol.
Aragon, barril = 4 wine arrobas	9·124	1·464	0·4144
Barcelona ,, = 2 mallals = 32 mitadellas . .	6·636	1·064	0·3014
,, oil barril = $7\frac{1}{2}$ cortanes	6·804	1·091	0·3090
Valencia, barril = $3\frac{3}{4}$ wine arrobas . . .	9·479	1·520	0·4305
Alicante, oil barril = $2\frac{1}{2}$ oil arrobas . . .	6·319	1·014	0·2870
Majorca, cortin = $6\frac{1}{2}$ corters (wine) . . .	5·976	0·958	0·2714
Minorca, barillo = $5\frac{1}{2}$ quartillos . . .	6·942	1·114	0·3153

Spanish barrels are mostly estimated by weight, and vary greatly.

ITALY :—			
Ancona, barile = 24 boccale	9·459	1·517	0·4296
Genoa, wine barrel = 50 pinte	16·344	2·622	0·7423
,, oil ,, = 64 quarteroni . . .	14·239	2·284	0·6467
Modena, wine ,, = 20 fiaschi	9·173	1·471	0·4166
Naples ,, ,, = 60 caraffe	9·604	1·541	0·4362
Palermo ,, ,, ...	7·865	1·262	0·3572
Rome ,, ,, = 32 boccali	12·845	2·060	0·5834
,, oil ,, = 28 boccali	12·658	2·030	0·5749
Sardinia, oil ,, = $3\frac{1}{2}$ pots	7·398	1·187	0·3360
Tuscany, wine ,, = 20 fiaschi (wine) . .	10·036	1·610	0·4558
,, spirits ,, ...	9·171	1·471	0·4165
,, oil orchio = 16 fiaschi (oil) . . .	7·360	1·180	0·3343
Bergamo, brenta = 52 pinte	15·822	2·538	0·7186
Cremona ,, ...	32·367	5·192	1·47
Milan ,, = 16 basse	16·632	2·668	0·7554
Parma ,, ...	15·853	2·543	0·72
Piacenza and Reggio, brenta	16·734	2·684	0·76
Piedmont, brenta = 36 pinte	10·850	1·740	0·4928
Verona ,, = 16 basse	15·523	2·490	0·7050
Belluna, mastello = 40 boccali	16·447	2·638	0·7470
Ferrara ,, = 40 ,, ...	12·194	1·956	0·5538
Padua ,, = 72 bozze	15·699	2·518	0·7130
Rome ,, = 40 boccali	18·081	2·900	0·8212
Rovigo ,, = 108 bozze	23·075	3·701	1·0480
Trevisa ,, = 36 boccali di campagna .	17·174	2·755	0·78
Venice ,, = 64 ,, ...	14·268	2·289	0·6480
Vicenza ,, = 120 bozze	25·079	4·023	1·1390
Bologna, corba = 60 boccali	16·247	2·606	0·7379
Lucca, coppo = 264 pounds of oil . . .	21·987	3·527	0·9986
Mantua, moggio = 320 pounds of oil . . .	24·519	3·933	1·1136

NOMINAL LIQUID MEASURES—*continued.*

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
GREECE, MEDITERRANEAN, &c. :—	on	Cub. ft.	Hectol.
Patras, barrel = 24 boccali (wine and brandy) .	11·284	1·810	0·5125
,, oil and honey barrel = 19 lb. or $25\frac{1}{3}$ bocc.			
Ionian I., wine and oil barrel = 4 jari . .	15·005	2·407	0 6815
Zante ,, ,, = 120 quartucci .	14·690	2·356	0 6672
Malta, wine and oil barrel = 2 caffisi, 11 old gallons	9·164	1·470	0·4162
Ragusa, oil and honey barrels = 84 centlets .	16·972	2·722	0·7708
Tripoli (Barbary), barrel = 24 bozze (Venetian) .	14·268	2·289	0·6480
Majorca, odre = 12 cortanes = 48 quartas . .	10·681	1·713	0·4851
JAPAN :—			
Koku = 10 to = 100 shöo = 1000 göo . . .	39·938	6·407	1·8141

LOADS.

The awm, ahm, ohm, and the tierce.

DENMARK, SWEDEN, AND GERMANY :—

The ahm is an expression for 4 ankers ; in some cases for 20 vierteln or $\frac{2}{3}$ oxhoft (see Ankers and Vierteln, pp. 165, 168, or see Oxhoft).

The exceptional ähmen are :—

Baden ahm = 10 stützen	33·027	5·297	1·50
Coblenz ,, = 27 vierteln	33·505	5·374	1·5217
Cöln ,, = 28 ,, ...	32·794	4·909	1·4894
Gotha ,, = 2 eimer	32·049	5·141	1·4555
Hanover ,, = $2\frac{1}{2}$,, = 4 anker . . .	34·242	5·492	1·5552
Würtemberg ohm, or eimer = 16 imi, $12\frac{1}{2}$ c. ft. .	64·715	10·381	2·9393
HOLLAND AND BELGIUM :—			
Old Amsterdam aam = 4 anker	34·172	5·481	1·552
Old Brussels aem = 24 schreef	28·628	4·592	1·3002
FRANCE (mesures anciennes) :—			
Parisian tierçon = 13 veltes	19·686	3·158	0·8941
Bordeaux ,, = 20 ,, ...	33·203	5·326	1·5080
Champagne ,, or demicaque = $7\frac{1}{2}$ veltes . .	11·729	1·881	0·5327
RUSSIA :—			
Warsaw, tierçon = 40 garniec (old) . . .	33·423	5·358	1·5171

NOMINAL LIQUID MEASURES—*continued.*

LOADS—*continued.*

Charges, carica, carga, salma, soma, saum.

	English Commercial Equivalent. Gallons	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Hectol.

SWITZERLAND :—

The saum is generally = 100 mass (see Mass). The exceptional saum were: Basel, 96 altmass; St. Gall, 128 mass; Grisons, 90 mass; Schaffhaus and Stein, 128 mass; Winthertur, 120 mass; Zurich, saums of 90 and of 96 mass.

SPAIN :—

The carga for wine or oil generally consists of 4 nominal barrels (see Barrels); its value varies locally from 27 to 36 gallons, and is, besides, differently estimated, even by Spanish metrologists.

ITALY :—

	Gallons	Cub. ft.	Hectol.
Soma (metric) = 10 mina	22·018	3·532	1
Ancona, soma = 2 barili = 48 boccali	18·918	3·034	0·8592
Tuscany ,, (oil) = 2 barili = 32 fiaschi	14·719	2·361	0·6685
Rome ,, ,, = 2 mastelli = 80 boccali	36·165	5·801	1·6425
Naples, salma ,, = 256 quarti	35·660	5·720	1·6196
Sicily, ordinary wine salma	18·341	2·942	0·8330
,, Messina wine salma = 8 barili	19·288	3·094	0·8760
,, Syracuse salma	17·139	2·749	0·7784
Cyprus, some or coriche	22·800	3·657	1·0355

HOGSHEADS.

Oxhoft, oxhufwud, barrica, barrique.

	Gallons	Cub. ft.	Hectol.
England, hogshead = $1\frac{1}{2}$ barrel (since 1803)	54	8·662	2·4525
Sweden, oxhufwud = $1\frac{1}{2}$ awm = 3 embar	51·84	8·316	2·3544
Denmark, oxehoved = $1\frac{1}{2}$,, = 6 anker	49·457	7·933	2·2462

GERMANY :—

	Gallons	Cub. ft.	Hectol.
Prussian oxhoft = $1\frac{1}{2}$ ahm = 6 anker	45·38	7·279	2·0611
Hanse towns ,, = $1\frac{1}{2}$,, = 6 ,,	47·83	7·671	2·1721
Brunswick ,, = $1\frac{1}{2}$,, = 6 ,,	48·57	7·790	2·2057
Hanover ,, = $1\frac{1}{2}$,, = 6 ,,	51·36	8·239	2·3328
Lippe-Detmold, oxhoft = $1\frac{1}{2}$ ahm = 6 anker	49·09	7·873	2·2294
Oldenburg ,, = $1\frac{1}{2}$,, = 6 ,,	50·42	8·087	2·2899
Saxony, Dresden ,, = $1\frac{1}{2}$,, = 6 ,,	44·53	7·142	2·0224
,, Leipzig ,, = $1\frac{1}{2}$,, = 6 ,,	50·10	8·035	2·2752

NOMINAL LIQUID MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Gallons	Cub. ft.	Hectol.
HOLLAND :—			
Amsterdam okshoofd = $1\frac{1}{2}$ aam = 6 anker . .	51·26	8·220	2·3280
RUSSIA :—			
Russian oxhoft = 12 stekar = 18 wedro . .	48·70	7·812	2·2119
Warsaw ,, = 60 garniec (old) . . .	50·10	8·037	2·2756
,, ,, = 60 ,, (metric) . . .	52·84	8·476	2·4000
SOUTHERN EUROPE :—			
The barrica of Southern Europe is a term for the half-pipe or demiqueue. (See Pipe.)			
SAN DOMINGO :—			
Barrica = 60 old wine gallons	49·99	8·018	2·2702

PUNCHEONS, *fass, vat, fat, &c.*

GERMANY :—			
Prussian fass, beer or brandy = 2 barrels . .	50·42	8·088	2·2901
Brunswick fass for mumme = 10 anker . .	80·94	12·983	3·6762
Brunswick ,, for beer = 4 ,, . .	87·42	14·021	3·9703
Gotha ,, for brandy = 1 ,, . .	44·07	7·068	2·0013
Hanover ,, for beer = 4 ,, . .	89·03	14·280	4·0434
Lübeck ,, ,, = 1 Hamburg oil fass = $1\frac{1}{4}$	31·88	5·114	1·4481
,, ,, for brandy = 1 oxhoft . . .	47·83	7·671	2·1721
Saxony, Dresden fass (beer) = 4 barrels . .	86·58	13·887	3·9324
,, Leipzig ,, ,, = 4 ,, . .	79·51	12·754	3·6114
,, Dresden ,, (wine) = 10 anker . .	74·21	11·904	3·3706
,, Leipzig ,, ,, = 10 ,, . .	83·5c	13·392	3·7919
AUSTRO-HUNGARY :—			
Bohemian fass (beer or wine) = 4 eimer . .	53·81	8·631	2·4438
Presburg ,, ,, = 4 eimer = 256 icze . .	46·98	7·536	2·1337
Tokay ,, (wine) = $2\frac{3}{4}$ Presburg eimer .	32·30	5·181	1·4669
JAMAICA :—			
Rum puncheon, variable nominal value; actual values between 72 and 108 gallons . . .	84	13·473	3·8151

NOMINAL LIQUID MEASURES—*continued.* BUTTS AND PIPES, *bota, pipa, queue.*	English Commercial Equivalent. Gallons	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Hectol.
Germany, Norway, Sweden, Denmark: The butt or pipe (when not imported) consists of 2 oxhoft. (See Oxhoft.)			
England, the butt = 2 hogsheads = 3 barrels .	108	17·324	4·9051
Russia: Sarokowaja-botschka for oil or brandy = 40 wedro	108·2	17·359	4·9154
Austria: weinfass = 10 eimer	124·6	19·985	5·6589
SPAIN :—			
Pipa of wine = 27 wine arrobas	95·9	15·387	4·3570
,, of oil = $34\frac{1}{2}$ oil arrobas	95·4	15·308	4·3347
Bota of wine = 30 wine arrobas	106·6	17·097	4·8411
,, of oil = $38\frac{1}{2}$ oil arrobas	106·5	17·084	4·8373
Local values.			
Alicante, pipa vino = 40 arrobas	101·7	16·320	4·6211
Barcelona, pipa (wine) = 4 cargas = 64 wine cortans, reputed trade value 100 gallons . . Barcelona, pipa (oil) = 119 oil cortans, same val.	106·2	17·031	4·8224
Cadiz, pipa (oil) = 34 oil arrobas . . .	94·1	15·087	4·2789
Malaga ,, (wine) = 25 arrobas	87·2	13·994	3·9623
,, bota (wine) = 30 ,, reputed trade value 100 gallons	104·7	16·792	4·7548
Malaga, pipa (oil) = 34 Castilian oil arrobas .	94·1	15·087	4·2719
,, bota (oil) = 42 ,, ,, .	116·2	18·637	5·2770
Teneriffe, pipa vino, varies from 116 to 124 old wine gallons; reputed trade value 100 gallons	100	16·040	4 5417
Valencia, pipa vino = 42 cantaros . . .	106·2	17·033	4·8221
,, pipe (oil) = 40 arrobas	101·1	16·217	4·5920
,, bota, or tonel = 100 cantaros . .	252·8	40·543	11·4800
Xeres, bota vino, 120 old wine gallons, English; reputed trade value 108 imperial gallons .	100	16·040	4·5417
Majorca, pipa (oil) = 108 cortanes . . .	96·1	15·421	4·3664
Minorca, pipa = 40 gerra; reputed trade value 105 gallons	106·2	17·041	4·8242
Malta, pipe = 11 barrels	100·8	16·175	4·5800
PORTUGAL :—			
Lisbon, pipa o bota = 26 almudes	94·7	15·188	4·3013
,, ,, for London, 31 almudes, reputed at 140 wine gallons	112·9	18·107	5·1274
Porto, pipa = 21 almudes, reputed at 115 gallons	116	18·598	5·2662
Madeira, pipa = $23\frac{1}{2}$ almudes, reputed at 92 galls.	92	14·708	4·1646

NOMINAL LIQUID MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Gallons	Cub. ft.	Hectol.
BRAZIL :—			
Rio Janeiro, pipa = 180 medidas	110·1	17·658	5
Bahia, pipa (rum) = 72 canhadas	112·6	18·032	5·1059
,, ,, (molasses) = 100 ,,	156·1	25·045	7·0915
ITALY &c. :—			
Rome, botta vino = 16 barili	205·5	32·967	9·3346
Venice, ,, = 10 mastelli	142·7	22·885	6·4800
,, anfora = 8 mastelli	114·1	18·308	5·1840
,, botta of oil = 2000 pounds weight.			
Vicenza ,, = 8 mastelli = ½ carro	200·6	32·181	9·1120
Naples ,, = 12 barili	115·3	18·486	5·2344
,, pipa = 14 ,,	134·5	21·567	6·1068
Sardinia, botta = 500 pinte	110·1	17·658	5
Messina, bota o pipa = 90 gallons	90	14·436	4·0876
Palermo, pipa = 12 barili	94·4	15·136	4·2858
Gallipoli, pipe of oil = 2⅘ salme	95·6	15·327	4·3400
Turin, carro = 10 brente	108·5	17·40	4·928
SWITZERLAND :—			
Geneva, char = 12 setier	120·8	19·369	5·4844
Waadt, char = 16 eimer = 48 broc	142·7	22·885	6·4800

TUNS, FUDER, TONELADA, TONNEAU, STÜCKFASS, KUFE, FASS.

England, tun of beer or ale = 2 butts	216	34·65	9·810
,, ,, whale oil = 210 gallons	210	33·69	9·539
,, ,, vegetable oil = 197 gallons	197	31·60	8·947
United States, tun = 200 wine gallons	166·6	26·74	7·570
Norway and Denmark, fuder = 2 pipes = 4 oxhoft	197·8	31·73	8·984
,, ,, stykfad = 1¼ fuder = 30 ankar	247·3	39·66	11·230
Former Elsinor tun, for wine, vinegar, and beer	204·2	32·75	9·274
,, ,, ,, of whale oil = 252 wine gals.	210·0	33·69	9·539
Sweden, fuhre = 2 pipas = 4 oxhufwud	207·4	33·26	9·418
GERMANY :—			
Hamburg tun of wine, or fass = 4 oxhoft	191·3	30·68	8·688
Danzig fuder = 2 both or pipes	181·5	29·11	8·244
Munich fass = 25 eimer	376·5	60·39	17·10
Heidelberg, stückfass = 150 vierteln	261·2	41·90	11·863
Frankfurt ,, = 1⅓ fuder = 8 ähmen	252·6	40·52	11·473
Nuremberg ,, = 1¼ ,, = 15 eimer	242·4	38·87	11·007
Vienna, dreiling = 3 fass = 30 eimer	383·1	61·45	17·40

NOMINAL LIQUID MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Gallons	Cub. ft.	Hectol.
SWITZERLAND :—			
Berne, landfass = 6 saum	220·8	35·41	10·027
,, fass = 4 saum = 26 brenten	147·2	23·609	6·6849
Freiberg, fass, or fahrt = 16 ,,	137·6	22·065	6·2477
Gruyère ,, = 16 brenten	220·0	35·280	9·9896
FORMER FRENCH UNITS :—			
Bordeaux, tonneau = 4 barriques = 6 tierçons	199·2	31·65	9·048
Le Havre ,, = 4 ,,	200·8	32·21	9·120
Nantes ,, = 2 pipes = 4 barriques	211·4	33·90	9·600
La Rochelle ,, = 4 barriques = 120 veltes	201·1	32·25	9·132
Marseille, tonneau d'huile	198·2	31·78	9
HOLLAND AND BELGIUM (former) :—			
Amsterdam, wine vat, or kufe = 60 aamen	201·3	32·29	9·144
,, olive oil vat = 717 mengel	187·9	30·14	8·534
Rotterdam ,, = 340 stoopen	191·6	30·73	8·700
Anvers, tun of Geneva	198·2	31·78	9·000
SPAIN :—			
Spanish tonelada = 2 botas = 4 barrigas	213·2	34·19	9·682
At Alicante, Barcelona, and in Valencia the tonelada = 2 pipas. (See Pipes.)			
PORTUGAL AND BRAZIL :—			
Lisbon, tonnelada = 2 pipas = 4 barricas	189·4	30·38	8·603
,, ,, de junta = 100 cubic palmos	176·1	28·25	8
Rio de Janeiro, tonelada = 2 pipas = 360 medidas	220·2	35·32	10
SICILY :—			
Messina, tonna = 12 salme	231·5	37·13	10·512
Syracuse, tonna = 12 salme	205·7	32·99	9·341
Naples, carro = 24 barili	230·6	36·97	10·469

NOMINAL LIQUID MEASURES—*continued.*

BREW, BRAU, GEBRÄUDE, BROUWSEL, BRASSIN.

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Barrels	Cub. rods	Hectol.
Berlin, gebräude = 9 kupen = 36 barrels . .	25·2	0·14558	41·22
Bremen, brau = 45 scheffeln	20·4	0·11772	33·333
Hamburg ,, = 50 barrels	55·9	0·30683	86·88
Dresden ,, = 12 kufe = 96 barrels . . .	57·7	0·33332	94·38
Leipzig ,, = 8 kufe = 64 ,, . . .	35·3	0·20406	57·78
Hanover ,, = 172 barrels	106·3	0·61405	173·87

DRY MEASURES.[1]

GENERAL VALUES.	English Commercial Equivalent. Bushels	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Litres
England: the Imperial bushel = 8 gallons; or 80 pounds of water	1	1·283	36·334
Germany: the Prussian scheffel = 4 viertel = 16 metzen = 3072 cubic inches	1·513	1·941	54·96
Norway and Denmark: the grain skieppe = 4 fierdingkar = 18 pott = 972 cubic inches	0·479	0·614	17·39
Norway and Denmark: the coal skieppe = 22 pots	0·585	0·751	21·25
Sweden: the spann = 4 fjerdingar = 16 kappar = 56 stop = 2·8 cubic feet	2·016	2·587	73·26
Russia: tschetwerik = 4 tschetwerka = 8 garnetz; or 64 funt of water	0·722	0·926	26·22
Austria: metze = 4 viertel = 16 muhlmässl	1·692	2·172	61·49
France: hectolitre of the metric system; Holland: mudde = 10 schepel = 100 kop; Italy: soma = 10 mina = 100 pinte; Rhenish Bavaria: hektoliter = 8 simmern	2·752	3·532	100
Waadt: quarteron = 10 mines = 100 copets = 500 cubic inches (metric)	0·372	0·477	13·50
Spain: Castilian fanega = 4 quartillas = 12 almudes, standard in 1830	1·508	1·935	54·80
Portugal: Lisbon fanga = 4 alqueiras = 8 meios	1·488	1·910	54·08
Turkey: kiloz of 22 okas of wheat	0·966	1·240	35·11

FORMER, LOCAL, AND SPECIAL VALUES.

GERMANY (Scheffeln):—

Prussian scheffel = 4 viertel = 16 metzen = 3072 cubic inches	1·513	1·941	54·96
Anhalt, scheffel of Koethen	1·458	1·870	52·96
Bremen, scheffel = 4 viertel = 16 spint; or 104 lbs. of rye	2·039	2·616	74·07
Elsass, scheffel = Parisian boisseau	0·358	0·459	13·01
Gotha, ,, = 2 viertel = 8 metzen	2·428	3·116	88·23
,, bergscheffel = 2920 cubic inches	1·106	1·420	40·20
Hamburg, scheffel (wheat) = 4 himten = 16 spint	2·903	3·725	105·48
Hamburg, scheffel (oats) = 6 himten = 24 spint	4·354	5·588	158·22

[1] The values of Small Dry Measures may be obtained by division.

DRY MEASURES—*continued.*

GERMANY—*continued*:—	English Commercial Equivalent. Bushels	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Litres
Hesse (Electoral), scheffel = 2 himten = 8 metzen	2·208	2·834	80·23
Holstein, the Danish skieppe	0·479	0·614	17·39
Lippe-Detmold, scheffel (wheat) = 6 large metzen = 24 mehlmetzen, 3154 cubic inches	1·219	1·564	44·29
Lippe-Detmold, scheffel (oats) = 7 large metzen	1·422	1·825	51·67
Lübeck, scheffel (wheat), 2343 cubic inches	0·919	1·180	33·40
,, ,, (oats), 2752 ,,	1·080	1·386	39·24
Mecklenberg Schwerin, scheffel (wheat) = 4 viertel = 16 spint	1·070	1·373	38·89
Mecklenburg Schwerin, scheffel (oats)	1·206	1·548	43·82
,, Strelitz, scheffel	1·422	1·824	51·65
Oldenburg, scheffel = 16 bierkanne	0·603	0·773	21·90
Saxe-Weimar ,, = 4 viertel = 16 metzen	2·118	2·718	76·97
Saxony ,, = 4 ,, = 16 ,, = 8064 cubic inches of Dresden, since 1719	2·914	3·740	105·89
Würtemberg, scheffel = 8 simri = 32 viertel	4·878	6·259	177·23
,, zuberscheffel = 4 imi = 40 mass	2·022	2·595	73·48
Schleswig, scheffel (wheat)	1·238	1·589	44·99
,, ,, (barley)	1·212	1·555	44·02
German sester, simmer, and large metzen.			
Bavaria, metze = 8 mässl	1·020	1·309	37·06
Brunswick, himt = 4 vierfass = 16 loechern	0·856	1·098	31·10
Baden, sester = 10 mässl = 100 becher	0·413	0·530	15
Strasburg, sester = 4 vierling = 16 mässl, town-measure, 924 cubic inches, Parisian	0·505	0·647	18·33
Strasburg, sester country measure, 952 Parisian cubic inches	0·520	0·667	18·88
Rhenish Bavaria, simmer = 4 vierling	0·344	0·441	12·50
Saxe-Coburg, simmer = 4 viertel = 16 metzen	2·416	3·099	87·76
Hesse-Darmstadt, simmer = 4 kümpfe = 16 gescheid	0·881	1·130	32
Nassau, simmer = 4 kümpfe = 16 gescheid	0·753	0·966	27·35
Nuremberg, metz (wheat) = 16 mass	0·547	0·702	19·88
,, ,, (oats)	0·506	0·649	18·39
AUSTRIA:—			
Metze = 4 viertel = 16 muhlmässl	1·692	2·172	61·49
Moravia, old metze	1·943	2·493	70·60
Bohemia, strich = 4 viertel = 16 mässl	2·576	3·306	93·60
Hungary, Pesth-Buda metze = 96 halben, or icze of 60 oka weight	2·206	2·826	80·02
Hungary, Temeswar and Presburg metze, or kila = 64 halben; or 40 oka weight, after 1808	1·468	1·884	53·34
Illyria, Fiume metze of 37½ wine boccali of 3456 Viennese cubic inches	1·739	2·231	63·17

DRY MEASURES—*continued.*

	English Commercial Equivalent. Bushels	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Litres
AUSTRIA—*continued* :—			
Illyria, Trieste staro	2·274	2·918	82·61
Galicia, Lemberg cwiercek = 8 garniec = 32 kwarti	0·846	1·086	30·75
Poland, Cracow cwiercek = 8 garniec = 32 kwarti	0·826	1·060	30·02
Tyrol, staro or star	0·841	1·080	30·57
Dalmatia, Ragusa roupell	0·682	0·875	24·77
Trent, staja	0·581	0·746	21·12
RUSSIA :—			
Imperial tschetverik = 4 tschetverka	0·722	0·926	26·22
Pernau, lof = 4 kulmitz (stricken)	1·743	2·236	63·32
Revel, ,, = 3 kullmet = 36 stof	1·085	1·393	39·43
Riga, ,, = 6 ,, = 54 ,,	1·880	2·412	68·29
Warsaw, cwiercek = 8 metric garniec, litres	0·881	1·130	32·00
,, ,, = 8 old garniec before 1819	0·830	1·065	30·15
FRANCE, HOLLAND, AND BELGIUM :—			
The old Parisian boisseau = 16 litrons	0·358	0·459	13·01
The boisseau métrique (1812-1840)	0·344	0·441	12·50
Amsterdam, old schepel = 32 koppen	0·744	0·954	27·02
Brussels, old halster	0·671	0·861	24·38
SWITZERLAND :—			
Arau, viertel = 4 vierling = 16 mässli	0·620	0·795	22·52
Basle, sester = 2 mudde = 8 kupfli = 16 becher	0·940	1·206	34·16
Berne, mäss = 2 mässli = 4 immi	0·386	0·495	14·01
St. Gall, viertel = 4 vierling = 16 mässlein	0·568	0·729	20·65
Geneva, bichet of 1957½ Parisian cubic inches	1·069	1·371	38·83
Grisons ,, = 4 quartanen = 16 mässlein	0·825	1·059	29·99
Lucerne ,, = 10 imni = 16 becher	0·956	1·227	34·75
Neufchâtel, setier = 8 pots = 24 copets	0·419	0·538	15·23
,, ,, for oats = 25 copet = 800 p. c., Paris	0·437	0·560	15·87
Schaffhausen, viertel = 4 vierling = 16 mässlein	0·622	0·798	22·60
Schwytz, Uri, Glaris, Zurich, viertel for corn	0·569	0·730	20·68
,, ,, ,, ,, ,, oats	0·576	0·738	20·91
Waadt, quarteron = 10 mines = 100 copets = 500 cubic inches	0·372	0·477	13·5
Wyl, viertel (grain) = 4 vierling = 16 mässlein	0·706	0·806	25·66
Zug ,, (wheat) = 4 ,, = 16 ,,	0·618	0·793	22·45
Ticino, large staro of Locarno	0·810	1·039	29·43
,, small ,, ,,	0·722	0·926	26·23
ITALY :—			
Soma = 10 mine = 100 pinte	2·752	3·532	100
Bergamo, stajo = 6 copelle	0·570	0·731	20·71
Bologna ,, = 4 quartaroli	1·016	1·303	36·90
Cremona ,,	0·982	1·260	35·67

DRY MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent
ITALY—*continued* :—	Bushels	Cub. ft.	Litres
Ferrara, staro = 4 quarti = 8 quartini	0·861	1·105	31·29
Mantua, stajo of 80 pounds	0·959	1·230	34·83
Milan, staro = 2 starelli = 16 metà	0·503	0·646	18·28
Modena, stajo	1·933	2·481	70·24
Padua ,, = 4 quartaruole	0·798	1·023	28·98
Parma, staro = 2 mine = 16 quartaroli	1·415	1·816	51·42
Piacenza, stajo = 2 mine	0·963	1·236	35·00
Reggio ,,	1·638	2·101	59·50
Rome ,, = $1\frac{1}{3}$ starello	0·675	0·866	24·53
Tuscany ,, = 2 mine = 16 mitadelle; or 50 lbs. of rye	0·670	0·860	24·36
Piedmont, staro	1·055	1·354	38·34
Venice ,, = 4 quarti = 16 quartaroni; or 132 pounds of wheat	2·293	2·942	83·31
Vicenza, stajo = 16 quartaruole	0·744	0·955	27·05
Sicily, bisaccia = 4 tomoli = 16 modilli	1·886	2·420	68·51
Naples, tomolo = 4 quarti = 24 misure; or 45 rottoli of wheat	1·520	1·950	55·22
SPAIN, PORTUGAL, AND SOUTH AMERICA :—			
Castilian fanega = 4 quartillas = 12 almudes	1·508	1·935	54·80
Ferrol ,, = 4 ferrados ($1\frac{1}{3}$ Castilian fan.)	2·011	2·581	73·07
Aragon ,, = 3 quartales = 12 almudes	0·621	0·797	22·56
Asturias ,, = 12 celemines	2·011	2·581	73·07
Canary Is. ,, = 12 almudes	1·723	2·211	62·60
La Havana ,, = 2 Castilian fanegas	3·016	3·870	109·60
Buenos Ayres, fanega = 3·75 Winchester bushels	3·635	4·664	132·07
Monte Video ,, = 3·75 Imperial ,,	3·750	4·812	136·25
Valparaiso, fanega for wheat and barley	2·498	3·205	90·75
,, ,, maize = 160 pounds	2·578	3·308	93·67
,, ,, potatoes = 200 ,,	3·222	4·135	117·08
San Antonio ,, wheat = 150 ,,	2·417	3·101	87·81
Concepcion ,, ,, = 175 ,,	2·830	3·618	102·45
Peru, ordinary ,, = 100 ,,	1·611	2·067	58·54
,, ,, wheat = 140 ,,	2·256	2·895	81·96
Mexico ,, grain, old Castilian value	1·555	1·995	56·49
,, ,, cacao = 110 pounds	1·773	2·274	64·40
Lisbon, fanga = 4 alqueiras = 8 meios = 16 quartos.	1·488	1·910	54·08
Oporto ,, = 4 ,, = 8 ,, = 16 ,,	1·879	2·411	68·27
Madeira ,, = 4 ,, = 8 ,, = 16 ,,	1·553	1·992	56·41
Azores ,, = 4 ,, = 8 ,, = 16 ,,	1·319	1·692	47·92
Brazil ,, = 4 ,, = 8 ,, = 16 ,,	1·488	1·910	54·08
TURKEY, THE LEVANT, &c. :—			
Kiloz of 22 okas of wheat	0·966	1·240	35·11
Bucharest, demerli of 16 okas	0·677	0·869	24·60
Morea, the Stamboul kiloz	0·966	1·240	35·11

DRY MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Bushels	Cub. ft.	Litres
TURKEY, &C.—*continued* :—			
Patras, the bachel	0·824	1·057	29·93
Negropont, kiloz	0·835	1·071	30·33
Cerigo, chilo = 1 Winchester bushel / Thiaki, bacile = 1 ,, ,,	0·969	1·243	35·20
Cephalonia, bacile = $1\frac{3}{8}$ Imperial bushel	1·375	1·764	49·95
Zante, bacile = $\frac{9}{10}$ Cephalonia bacile	1·238	1·603	45·38
Corfu and Paxos, misura	0·578	0·743	21·05
Cyprus, coffino	0·544	0·698	19·76
,, moose of 40 oka of wheat	1·761	2·26	64·00
Malta, tummolo (stricken measure)	0·498	0·639	18·10
SYRIA AND ARABIA :—			
Smyrna, kilo of 32 okas of wheat	1·412	1·812	51·30
Mokha and Beitulfakiah, teman = 40 kella or mecmeda, 168 pounds (avoir.) of rice	2·625	3·369	95·38
EGYPT AND ABYSSINIA :—			
Gondar, ardeb = 10 madega	0·121	0·189	4·40
Massowah, ardeb = 24 madega	0·291	0·453	10·56
(See also Large Dry Measures.)			
TUNIS AND ALGIERS :—			
Tunis, weba = 12 saa	0·909	1·167	33·03
Tripoli, temen = 4 orba = 8 nasforba	0·739	0·948	26·84
Algiers, tarri	0·546	0·701	19·84
NORTHERN INDIA :— (Grain is sold by weight.)			
The English cubic foot (commercial value)	0·779	0·999	28·29
The French hectolitre	2·752	3·532	100
In Sindh the cossah = 4 toyah	0·321	0·412	11·67
SOUTHERN INDIA :—			
Bombay, parah (grain) = 28 ser measures	0·254	0·326	9·22
,, ,, (salt) = 40 ,,	0·725	0·930	26·33
Anjar, shahi = 4 map = 32 palli	0·855	1·098	31·08
Cochin, parah = 45 local measures	0·875	1·123	31·79
Madras ,, = 40 measures, or 4000 cubic in.	1·802	2·313	65·49
Ballari ,, = 60 ser measures	2·023	2·597	73·52
Bangalur, colagah = 8 ser measures	0·269	0·346	9·80
Madura, markal = 6 measures	0·298	0·380	10·75
Travancor, parah = 10 dungalli	0·043	0·057	1·58
Masulipatam, markal = 12 zavah = 96 giddah	0·391	0·501	14·19
Negapatam ,, = 4 measures (grain)	0·113	0·146	4·12
Palamkattah ,, = 6 bazar measures	0·270	0·346	9·79

DRY MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Bushels	Cub. ft.	Litres
SOUTHERN INDIA—*continued*:—			
Dindigal ,, = 5 measures	0·264	0·338	9·58
Trichinopalli ,, = 4 ,,	0·139	0·178	5·04
Pondicherri ,, of 12 liv. p. de marc	0·193	0·247	7
CEYLON:—			
Colombo, parah = 2 markal = 24 ser measures	0·702	0·902	25·54
BURMAH:—			
Rangun, basket, parah or teng, 16 vis of rice = 8 sa	0·833̇	1·069	30·28
Pegu ,, ,, 16 ,, = 8 ,,	0·848	1·089	30·82
THAÏ (SIAM):—			
Thangsat = 20 thanan = 2000 cubic niu	0·522	0·669	18·95
ANAM (COCHIN CHINA):—			
Tao = 2 hao	1·556	1·996	56·52
MALACCA AND SUMATRA:—			
Malacca, gantang	0·110	0·141	4
Singapore ,, = 4 chupa	0·122	0·157	4·45
Sumatra, sukat = 12 pakha	0·182	0·233	6·60
Bencoolen, kula, or bambu = 4 chupa	0·122	0·146	4·42
Palembang, gantang of 6 catti of grain	0·135	0·173	4·90
,, bally = 10 gantang	1·349	1·731	49·00
Acheen, nelli = 8 bambu = 32 chopa	0·480	0·616	17·45
JAVA, BORNEO, MOLUCCAS, CELEBES, &c.:—			
Bantam, gantam = 8 bambu	0·716	0·918	26·00
Batavia, gantang	0·264	0·339	9·60
Borneo ,, 20 pounds troy (Dutch) rice	0·358	0·459	13·00
Macassar, home gantang	0·138	0·177	5
,, export ,, 11½ lbs. troy (Dutch) rice	0·206	0·265	7·5
Mindanao, battel, or raga = 10 gantang	0·440	1·130	32·00
CHINA:— (Grain is sold by weight.)			
Tche = 10 teu = 100 tching	1·927	2·472	70·00
JAPAN:—			
To = 10 shöo = 100 göo	0·897	0·641	18·14
SOUTH AFRICA:—			
Madagascar, trubahuash, or monka = 2 bambu = 12 voules	0·110	0·141	4·00
Madagascar, zatu = 100 voules, rice	0·918	1·177	33·33
Cape of Good Hope, bally = 5 gantang	1·266	1·625	46·00

LARGE DRY MEASURES.

GENERAL VALUES.	English Commercial Equivalent. Bushels	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Hectols.
England: the quarter = 8 bushels; 640 lbs. of water	8	10·266	2·9067
Germany: the Prussian malter = 12 scheffeln = $21\frac{1}{3}$ cubic feet	18·152	23·292	6·595
Norway and Denmark: the toende (barrel) = 4 fierde = 8 skieppe = $4\frac{1}{2}$ cubic feet	3·829	4·913	1·391
Sweden: the tunna = 2 spann = 112 stop = 5·6 cubic feet	4·032	5·174	1·465
Sweden: augmented tunna, $12\frac{1}{2}$ per cent. added, = 6·3 cubic feet	4·536	5·821	1·648
Russia: tschetwert = 4 pajok = 8 tschetverik; 512 funt of water, or 10 pud of wheat	5·772	7·407	2·097
Austria: the grain muth = 30 metzen	50·768	65·145	18·446
Spain: cahiz = 12 fanegas	18·099	23·226	6·576
Portugal: moio = 15 fangas	22·326	28·649	8·112
Turkey: fortin = 4 kiloz; 2 kanthar of wheat	3·865	4·960	1·404
Syria: makuk of Aleppo; 250 rotl of grain	22·018	28·253	8·000
Egypt: ardeb of Cairo	4·800	6·160	1·744
Morocco: almud or mud	5	6·416	1·817
China: ping = 8 tche	15·413	19·778	5·600

FORMER, LOCAL, AND SPECIAL VALUES.

GERMANY:—

Prussian malter = 12 scheffeln; $21\frac{1}{3}$ cubic feet	18·152	23·29	6·595
,, winspelkarre, 7 cubic feet	5·956	7·64	2·164
Anspach, simra of wheat = 17 metzen	9·306	11·94	3·381
,, ,, oats = 576 mass	17·177	22·04	6·241
Baireuth ,, = 16 maes	13·648	17·51	4·959
Baden, malter = 10 sester = 100 mässl	4·128	5·30	1·500
Bavaria, scheffel = 6 metzen = 8944 cubic inches	6·120	7·85	2·224
Brunswick, scheffel = 10 himten = 40 vierfass	8·560	10·98	3·110
Coblentz, malter = 8 simmern = 32 sester (stricken)	5·224	6·70	1·898
Cöln ,, = 4 fässer = 8 simmern	3·951	5·07	1·435
Elsass, sac, or résal = 8 boisseaux de Paris; 160 poids de marc pounds of wheat	2·862	3·68	1·041

LARGE DRY MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
GERMANY—*continued*:—	Bushels	Cub. ft.	Hectols.
Eisenach, malter = 2 scheffeln	8·080	10·37	2·936
Frankfurt ,, = 4 simmern = 8 metzen . .	3·158	4·05	1·147
Gotha ,, = 2 scheffeln = 16 ,, . .	4·857	6·23	1·765
,, charcoal malter (see Cubic Measures).			
Hamburg, sac[1] = 2 scheffeln = 4 fässer = 8 himten	5·806	7·45	2·110
Hanover, malter = 6 himten	5·136	6·59	1·866
Hesse-Cassel, viertel = 2 scheffeln = 16 metzen .	4·415	5·67	1·605
Hesse-Darmstadt, malter = 4 simmern = 16 kümpfe	3·523	4·52	1·280
Homburg, viertel = 4 himten = 16 metzen . .	4·910	6·30	1·784
Mainz, malter = 4 simmern = 16 kümpfe . .	3·010	3·86	1·094
Lubeck, droemt of wheat = 12 scheffeln . .	11·034	14·16	4·009
,, ,, oats = 12 ,, . .	12·958	16·63	4·708
Rostock ,, wheat = 12 ,, . .	12·844	16·48	4·667
,, ,, oats = 12 ,, . .	14·471	18·57	5·258
Nassau, malter = 4 simmern = 16 kümpfe . .	3·010	3·86	1·094
Nuremberg, simmer (wheat) = 16 metzen . .	8·755	11·24	3·181
,, ,, (oats) = 4 malter = 32 metzen	16·194	20·78	5·884
Oldenburg, molt[1] = $1\frac{1}{2}$ barrel[1] = 12 scheffeln .	7·233	9·28	2·628
Saxony, malter = 12 scheffeln (Dresden) . .	34·972	44·88	12·707
Schleswig and Holstein, the Danish barrel[1] toende	3·829	4·91	1·391
Schleswig, heitscheff = $2\frac{1}{2}$ scheffeln . . .	3·095	3·97	1·125

The winspel of grain.

is in Prussia = 2 malter; in Brunswick = 4 scheffeln;
in Hanover = 8 ,, at Hamburg = 10 ,,
in Saxony = 2 ,, at Rostock = 32 ,,

AUSTRIA:—	Bushels	Cub. ft.	Hectols.
Grain müth = 30 metzen	50·768	65·15	18·446
Hungary, Temeswar schinek = 2 metzen; 80 okas	2·936	3·77	1·067
Slavonia, kila = $3\frac{1}{2}$ Presburg metzen = 224 halben	5·138	6·59	1·867
Galicia, Lemberg korzec = 4 kwerki = 32 garniec	3·385	4·34	1·230
Poland, Cracow korzec = 4 kwerki = 32 garniec .	3·306	4·24	1·201
Dalmatia, Ragusa stajo = 6 roupell . . .	4·090	5·25	1·486
Trent, soma = 8 staja	4·651	5·97	1·690
RUSSIA:—			
Imperial tschetwert = 8 tschetverik; 512 lbs. of water	5·772	7·41	2·097
Finland, Swedish tunna[1] augmented . . .	4·536	5·82	1·648
Narva, grain barrel[1] = 4 viertel = 32 kapp . .	4·462	5·72	1·621
Pernau ,, ,, = 2 lof = 8 kullmets . .	3·484	4·47	1·266

[1] For other barrels of dry merchandise see text, pp. 156 and 157.

LARGE DRY MEASURES—*continued.*

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Bushels	Cub. ft.	Hectols.
RUSSIA—*continued* :—			
Revel, grain barrel[1] = 3 lof = 9 kulmet = 108 stof.	3·256	4·18	1·183
Riga ,, ,, = 2 ,, = 12 ,, = 108 ,,	3·760	4·82	1·366
Warsaw, korzec = 4 kwerki = 32 garniec (metric)	3·523	4·52	1·280
,, ,, = 4 ,, = 32 ,, (before 1819)	3·319	4·26	1·206
FRANCE, HOLLAND, AND BELGIUM :—			
Old Parisian setier of grain = 12 boisseaux	4·294	5·51	1·561
,, ,, salt = 16 ,,	5·723	7·35	2·081
,, ,, oats = 24 ,,	8·588	11·03	3·122
,, ,, charcoal = 32 ,,	11·446	14·70	4·163
Amsterdam, sac = 3 schepeln = 96 koppen	2·231	2·86	0·811
Brussels, muid = 6 rasières = 24 vierteln	8·052	10·33	2·926
SWITZERLAND :—			
Arau, malter = 4 mütt = 16 viertel	9·916	12·73	3·603
Basel, vierzel = 2 sac = 8 sester = 64 kupfli	7·522	9·65	2·733
Berne, mütt = 12 maess (11520 cubic inches)	4·627	5·94	1·681
St. Gall, malter = 2 mütt = 8 viertel	4·547	5·83	1·652
Geneva, sac = 2 bichets ; 110 lbs. of wheat.	2·139	2·74	0·777
Glaris and Schwytz, the Zurich malters.			
Grisons, lädi = 8 mütt = 44 viertel	36·330	46·62	13·20
Lucerne, malter = 4 mütt = 16 viertel	15·304	19·64	5·561
Neufchâtel, sac = 8 setiers	3·355	4·31	1·219
Schaffhausen, grain malter = 2 mütt = 8 viertel	4·956	6·39	1·808
Waadt, sac = 10 quarterons = 100 emines	3·716	4·77	1·350
Wyl, grain malter = 2 mütt = 8 viertel	5·651	7·25	2·053
Zug ,, ,, = 4 ,, = 16 ,,	9·884	12·68	3·591
Zurich, malter (grain) = 4 mütt = 16 viertel ($12\frac{1}{4}$ cubic feet)	9·106	11·68	3·308
Zurich, malter (oats and vegetable) = 16 viertel ($12\frac{7}{18}$ cubic feet)	9·209	11·82	3·346
ITALY :—			
Ancona, rubbio = 8 coppe	7·874	10·10	2·861
Bergamo, soma = 8 staja	4·561	5·85	1·657
Bologna, corba = 2 stari = 8 quartaroli	2·031	2·61	0·738
,, fruit corba = 3 stari	3·046	3·92	1·107
Brescia, soma = 12 quarti	4·018	5·16	1·460
Cremona, sac = 3 staja	2·945	3·78	1·070
Ferrara, moggio = 20 staje	17·226	22·11	6·259
Genoa, mina = 8 quarti = 96 gombette	3·322	4·26	1·207
Milan, rubbio = 2 moggia = 16 staja	8·049	10·33	2·925
Modena, saco = 2 staja	3·496	4·49	1·270
Padua, moggio = 12 staje	9·572	12·28	3·478
Piedmont, sacco = 5 emine = 10 quartieri	3·165	4·06	1·150
Reggio ,, = 2 staja	3·275	4·20	1·190

[1] For other barrels of dry merchandise see text, pp. 156 and 157.

LARGE DRY MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
ITALY—*continued*:—	Bushels	Cub. ft.	Hectols.
Rome, rubbio = 12 staja	8·103	10·40	2·944
Tuscany, rubbio = $3\frac{3}{4}$ sacchi = $11\frac{1}{4}$ staja	7·541	9·68	2·740
,, moggio = 8 ,, = 24 staji	16·091	20·65	5·846
Venice ,, = 4 stari = 16 quarti	9·172	11·77	3·333
Verona, sacco = 3 minelli = 12 ,,	3·157	4·05	1·147
Vicenza ,, = 4 staja	2·978	3·82	1·082
Sicily, salma = 4 bisaccie	7·543	9·68	2·741
Naples, carro = 36 tomoli	54·718	70·21	19·881
SPAIN AND SOUTH AMERICA:—			
Castilian cahiz = 12 fanegas = 52700 pul. cub.	18·099	23·23	6·576
Alicante ,, = 12 barcellas = 48 almudes	6·781	8·70	2·464
Aragon ,, = 8 fanegas = 96 ,,	4·968	6·37	1·805
Valencia ,, = 12 barcellas = 48 ,,	5·649	7·25	2·053
Barcelona, salma = 48 cortanes	7·816	10·03	2·840
Buenos Ayres, cahiz = $3\frac{3}{4}$ fanegas	13·631	17·49	4·953
PORTUGAL AND BRAZIL:—			
Moio for grain and salt = 15 fangas = 60 alqueiras	22·326	28·65	8·112
Moio for lime = 50 alqueiras	18·605	23·87	6·760
,, for limestone = 30 alqueiras	11 163	14·33	4·056
TURKEY, LEVANT, &c.:—			
Fortin = 4 kiloz of 2 canthar of wheat	3·865	4·96	1·404
Bucharest, kile = 2 mirze = 16 demerli; 256 oka of wheat	10·833	13·90	3·936
Ibrahil, kilo of 400 oka of wheat	17·614	22·60	6·400
Moldavia, Galatz kilo	11·284	15·01	4·250
Salonica, kilo of 85 oka	5·337	6·85	1·939
Corfu and Paxos, moggio = 8 misure	4·635	5·95	1·684
Thiaki, moggio = 5 bacile	4·844	6·22	1·760
Malta, salma rasa = 16 tummoli	8·000	10·27	2·907
SYRIA:—			
Aleppo, makuk of 250 rottal	22·018	28·25	8·000
Smyrna, fortin = 4 kiloz	5·648	7·25	2 052
Acre ardeb	9·358	12·01	3·400
EGYPT:—			
Alexandria, kilo of 202 Amsterdam koppen	4·694	6·03	1·706
,, Rosetta ardeb = $7\frac{3}{4}$ Imp. bushels	7·750	9·95	2·816
,, Damietta ,, for rice	11·180	14·35	4·062
Cairo, flax ardeb = $4\frac{4}{5}$ Imperial bushels	4·800	6·16	1·744

For ABYSSINIA see p. 183.

LARGE DRY MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
TUNIS, MOROCCO, ALGIERS:—	Bushels	Cub. ft.	Hectols.
Morocco, almud, or mud	5	6·42	1·817
Algiers, caffiso = 16 tarri	8·737	11·21	3·174
Tunis ,, = 16 weba	14·545	18·66	5·285
Tripoli, weba = 4 temen; 210 rottol of wheat	2·954	3·79	1·073
PERSIA:—			
No measures of capacity.			
NORTHERN INDIA:—			
In Moslem Asia generally, grain is sold by weight, and measures of capacity are rarely used.			
Sindh, karwal = 60 cossah	19·266	21·19	7
SOUTHERN INDIA:—			
Anjar kulsey = 19 shai	13·688	17·56	4·973
Bombay, the kandi = 8 parah of grain	2·032	2·91	0·738
,, rice kandi = 12 ,, ,,	3·044	3·91	1·106
,, mora or muddi = 25 grain parah	6·342	8·14	2·304
Madras, kandi = 4 parah	7·208	9·25	2·620
Colombo, ammonam = 8 ,,	5·623	7·21	2·043
The kandi of capacity in Southern India corresponds to the kandi of weight of various merchandise, it hence varies greatly. Estimation by weight is the more usual method.			
CHINA:—			
Ping = 8 tche	15·413	19·78	5·600
JAPAN:—			
Koku = 10 to = 100 shöo	4·992	6·41	1·814
MANILA:—			
Kaban = 25 ganta, rice	2·750	3·53	0·999
Kaban of cacao = 80 libras castillañas.			

NOMINAL DRY MEASURES.

Grain Lasts. GENERAL AND FORMER LOCAL UNITS.	English Commercial Equivalent. Quarters	English Scientific Equivalent. Cub. ft.	French Scientific Equivalent. Hectols.
England : grain last = 10 quarters	10	102·66	29·067
Danish and Norwegian: last = 22 toende (barrels) or 99 cubic feet	10·530	108·09	30·607
Sweden : last of rye = 24 tunna (augmented) .	13·609	139·70	39·558
,, ,, barley = 27 ,, ,, .	15·310	157·17	44·503
,, ,, oats = 30 ,, ,, .	17·011	174·63	49·448
GERMANY :—			
Prussian last of wheat or rye = 6 matlern = 128 cubic feet	13·614	139·75	39·572
Prussian last of barley or oats = 4 maltern. .	9·076	93·17	26·382
Bremen, last = 40 scheffeln	10·193	104·64	29·628
Brunswick, last = 10 ,, ...	10·698	109·85	31·103
Hamburg ,, = 60 fässer	10·887	111·76	31·644
Hanover ,, = 16 maltern	10·271	105·45	29·859
Lübeck ,, of wheat = 8 droemten = 24 barrels	11·034	113·27	32·072
Lübeck, last of oats = 8 droemten	12·958	133·02	37·664
Oldenberg, last = 18 barrels = 144 scheffeln .	10·849	111·37	31·535
Rostock, last of wheat = 8 droemten . .	12·844	131·85	37·336
,, ,, oats = 8 droemten	14·471	148·56	42·064
RUSSIA :—			
Grain last = 19 tschetwert	11·544	118·51	33·556
Finland (see Swedish lasts)			
Narva, last = 24 barrels = 96 vierteln . .	13·38	137·4	38·90
Pernau, last = 24 barrels = 48 lof . . .	10·46	107·3	30·39
Revel, last = 24 barrels = 72 lof . . .	9·77	100·3	28·39
Riga, rye last = 15 tschetwert	10·823	111·10	31·458
,, wheat and barley last = 16 tschetwert .	11·544	118·51	33·556
,, oats last = 20 tschetwert	14·430	148·13	41·944
Warsaw ,, = 30 korzec (metric) . . .	13·211	135·62	38·400
,, ,, 30 ancient korzec, before 1819 .	12·448	127·79	36·183
HOLLAND AND BELGIUM :—			
Amsterdam, metric last = 3 mètres cubes = 30 mudden = 300 schepeln	10·321	105·95	30
Old Amsterdam last = 36 sacs (grain) . .	10·039	103·06	29·182
SOUTHERN EUROPE AND AMERICA :—			
Spanish last = 3 cahices	9·049	92·90	26·304
Buenos Ayres, last = 4 cahices	6·816	69·96	19·810

NOMINAL DRY MEASURES—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
SOUTHERN EUROPE AND AMERICA—*continued*:—	Quarters	Cub. ft.	Hectols.
Lisbon and Brazilian last = 4 moios = 60 fangas	11·163	114·60	32·449
Syria, garava	4·988	51·21	14·50
Genoa, last = 25 mines	10·381	106·57	30·175
Livorno ,, = 40 sacchi = 120 staji	10·057	103·24	29·232
NORTHERN INDIA :— (Grain is sold by weight.)			
Calcutta, kahun of 40 man	6·004	61·63	17·45
SOUTHERN INDIA AND BURMA :—			
Cambay, coyang	8·257	84·76	24
Madras, garsah = 20 kandi = 80 parah	18·025	185·03	52·391
Masulipatam, garsah = 5 kandi = 400 markal	19·53	200·49	56·768
Maisur, garsah = 521 pukkaser	2·196	22·54	6·383
Pondicherri, garsah = 600 markal	14·445	148·29	41·988
Colombo, last = 75 parah	6·595	67·70	19·17
Ceylon, garsah = 25 ammonam	17·548	180·26	51·081
Rangoon, coyan = 100 baskets	10·417	106·93	30·28
MALACCA, &c. :—			
Malacca, coyang = 80 mass, or sacks; Thai (Siam), cohi = 40 seste	11·009	113·01	32
Thai, coyan = 80 thangsat	5·215	53·54	15·16
Malacca, last = 50 mass, or sacks	6·881	70·63	20
Singapore, coyang = 40 sacks, or pecul	12·248	125·73	35·60
SUMATRA AND FORT MARLBOROUGH :—			
Sumatra, coyang = 80 tub = 800 sukat	18·16	186·49	52·79
Bencoolen and Fort M. coyang = 800 kula	12·166	116·47	35·36
Palembang, coyang = 80 balli	13·486	138·44	39·2
Acheen, coyang = 100 nelli = 800 bambu	6·004	61·63	17·45
JAVA, BORNEO, MOLUCCAS, CELEBES :—			
Amboyna, coyang, 3000 lbs. T. D. rice	6·709	68·87	19·5
Bantam ,, = 200 gantam, 8000 lbs. T. D.	17·890	183·65	52·0
Batavia ,, = 230 gantam, 3375 lbs. T. D.	7·819	77·70	22·0
SOUTH AFRICA :—			
Cape of Good Hope, last = 46 balli = 230 gantang of 3200 lbs. (Dutch Troy) of wheat	7·283	74·73	21·16

Lasts of miscellaneous merchandise are either based on weight, as weight-lasts ; or on cubic measure, as shipping-tons, or lasts of measurement. For lasts of capacity used in the Baltic trade, deduce from values of barrels, given in the text at pp. 156 and 157.

CHAPTER VI.

MEASURES OF WEIGHT.

THE classification of measures of weight into two categories,

1. Purely commercial,
2. Monetary and medicinal,

is the method most usually adopted by metrologists, and is also a convenient mode of separating the voluminous amount of and variety of weights in use throughout the world.

Medicinal weights are necessarily small, so also are those for precious metals and precious stones, while the commercial weights have an enormous range, from the granottino of Turin, of which 165 888 went to a rather small pound, up to the Russian perma of nearly four tons, a very large unit approached by the Spanish cajon of about two tons, and only seriously exceeded by the enormous maniasa of Bhopal and Malwah, which vary from about 15 to nearly 22 English tons.

There appears, however, never to have been any actual need for separate monetary and commercial systems of weight, although the smaller subdivisions necessary to a monetary system as well as to a medicinal one would require an arrangement suited to the greater delicacy and refinement of the operations of testing

money and compounding minute quantities of drugs. On examining the old English monetary system of weight, in which the still used Troy grain was divided into 11 520 periots, and the periot into 24 blanks, units actually used and referred to in old records, the conclusion at once suggests itself that any such grain whether commercial or not would have answered the same purpose, apart from the disadvantages accompanying a change. The principle of selection is the same when applied to measures intended for one purpose as it is to another; a unit is to be forthcoming at the points of a general scale where convenience demands them, and the secondary units in the scale must be multiples and submultiples of those units placed at other convenient points in the scale. A single system of measures may hence be made to include any multiples and submultiples to any degree of any one unit once determined, without adopting the coarse expedients either of a detached system, or of borrowing foreign-units.

It is only very recently that the principle of systematic uniformity has been thoroughly and entirely accepted in England. The old apothecaries' weight-system and the old Troy weight-system are now nominally discarded, and will become really obsolete very shortly after some perfect mode of supplanting them is arranged.

At present the Troy ounce is the marked relic of that system, the Canadian Government having obtained standards of the Troy ounce from England as late as 1875; and the apothecaries' dram of 60 grains cannot be expected either to make way for the inconvenient avoirdupois dram of 27·3475 grains, or to be practically abolished until some more perfect arrangement

be made; the abolition and the transition are incomplete.

The adjustment of this matter appears to involve much difficulty. The practical requirements are that the dram should consist both of some convenient submultiple of the ounce, and be some convenient multiple of the grain, so as to admit of halving and quartering in aliquot numbers. The difficulties result from the unfortunate conjunction of the binary and the septimal modes; the pound is divided by one method into sixteenths or ounces, and those again into sixteenths, thus arriving at the 256th part in one mode, while the pound is also divided into 7000 parts or grains on another method. The advantages of both binary and decimal modes cannot be preserved in a septimal system; the halving and quartering, doubling and quadrupling in a binary system are of practical convenience in actual weighing, while the decimal multiplication and division is convenient when dealing with far-separated units, and generally facilitates calculation; the question therefore arises, which advantages should be preserved, and which rejected.

Considering the English system as a whole, and bearing in mind that the capacity-measures are binary throughout, a corresponding mode might appear suitable also in the series of weights.

The cause of the difficulty is evidently inherent in the original engrafting of the Troy system on to the avoirdupois system, each of which were complete and convenient to a certain degree.

The old Troy pound consisted of 5760 grains Troy, and the avoirdupois pound of 7680 grains avoirdupois; both of these pounds were quite unnecessarily

introduced from France into England, and eventually a combination was effected, the avoirdupois grain was abolished and the avoirdupois pound was declared equal to 7000 grains Troy exactly ; the convenient subdivision of this purely accidental number 7000 in accordance with the traditional submultiples of either one class or the other is the apparent stumbling-block.

Before the introduction of these foreign measures of weight, the Anglo-Saxon or real English weights answered every purpose, and were much superior to the innovations, said to have been imported by the Black Prince after the annexation of France.

The Anglo-Saxon moneyer's pound, afterwards termed the Tower pound, consisted of 12 ounces, or 20 shillings, or 240 pence ; and the pennyweight being 32 grains, this pound was 7680 Anglo-Saxon grains ; the merchant's pound consisted of 15 such ounces or of 9600 Anglo-Saxon grains (0·703125 grs. Troy). The values of these pounds given in the tables are based on the data given in the Reports of the Warden of the Standards. The Anglo-Saxon ounce hence was 640 grains, a number admitting of continuous halving down to 5 grains. The analogy between this subdivision of the merchant's pound into 9600 grains, and the existing subdivision of the pint into 9600 minims, affords evidence of the natural English method of suiting their measures to their own practical requirements, and of their marked preference for binary subdivision.

The monetary weights of olden time were of much greater importance than the commercial weights, and show traces of greater care and nicety of arrangement. The repeated weighing of money, of which much was debased, clipped, defective, and very irregular in form,

was then a necessity ; while at present improved coinage and severe penal enactment render it comparatively needless, and at the same time principally confine monetary measures to the hands of a special and limited number of persons. In fact, recognition of coin and the acceptance of tokens of perfect form has superseded weighing money as a general rule ; the scale is not now much used for silver coin, and though retained for gold coin it is perhaps not used for more than five per cent. of the cases where gold coin is accepted in ordinary trade of the country. Such a custom could never have existed with the pieces of money, crooked, much battered, and very variable, that have been handed down to us from antiquity, nor before the penal edicts that provide imprisonment for half a life-time as the meed for making payment with a bad shilling, or as it is termed, uttering base coin. Comparatively modern experience in India with the rupees of native States proves the necessity for perpetual weighing that must have similarly been required not only with the silver pence of the Anglo-Saxon period, but, if we may judge from the comparative rarity of perfect ancient pieces of money, also with the mass of the money of all nations in olden time.

At present, an unknown coin is either rejected or valued as so much metal, and the reputed fineness of the coins and tokens of other countries is the basis of their valuation. Not only is Troy weight now unnecessary, but it always was so ; for, on examining the whole of the old Continental monetary systems, fully three quarters of them were merely marc systems, in which the marc was exactly half a commercial pound (the cases in which it was two-thirds are exceptional) ; the marc was divided into 16 lodes, or loth, in the same

way as the pound was divided into 16 ounces, and the commercial units were simply doubled monetary units. If then a unit approximating to the present avoirdupois ounce is not now suited to the requirements of Mint-officials, and a smaller unit be necessary, the adoption of a monetary marc of half a pound, or even merely of a monetary lode of half an ounce, would be sufficient for all purposes, provided the subdivision were also rendered convenient.

The English subdivision of the Troy ounce was—

1 ounce = 20 pennyweights = 480 grains = 9600 mites

and the mite was anciently divided into—

24 doits = 576 periots = 13824 blanks.

The latter series has been long discarded as unnecessary, but the former part, the subdivision of the ounce into 9 600 parts, follows the natural and typical English method, formerly applied to the merchant's pound and still applied to the pint, that will probably be never improved upon for practical purposes, although it is inferior for purposes of very rapid calculation.

The subdivision of the Cöln loth, which was the 16th of the Cöln marc, or Continental unit of monetary measure, was: 1 loth, or lode = 4 drams or quentchen = 16 pfennig or pennyweights = 32 heller = 272 ässchen, but the further division of the ass was unsystematic and clumsy.

It may here be noticed that the marcs or half-pounds mentioned in the tables of Continental commercial pounds were not necessarily units of monetary weight, for in a few cases they were mere commercial

submultiples: besides this the term marc was frequently applied to a unit of fineness of metal in distinction to a fixed value either of commercial or monetary weight, and in that form was the basis of a ratio, differently expressed for gold and for silver. A marc cannot therefore be invariably treated as a monetary half-pound when mentioned in connection with Continental systems.

The modes of subdivision above mentioned, indicate practical requirements to be remembered when superseding the old Troy weight by new arrangements. There is, however, another alternative method of arranging new measures and their subdivision; it consists in entirely ignoring all practical requirements and all the convenience afforded by choice of suitable unit, in forming a rigid decimal scale based on any unit whatever taken at hazard, and depending on the chance that some one of the decimal sub-multiples will be near enough to answer any required purpose. Such a method is generally attributed to scientific men that are indifferent to the public convenience, and is stigmatised perhaps justly, as a very coarse and unscientific mode of doing things; though more strictly it amounts to a mode of avoiding the care and thought involved in producing anything useful.

The former apothecaries' weights in use in Europe are mentioned in the tables of medicinal systems. The Nuremberg medicinal pound and system of subdivision was that most widely adopted, in the same way as the Cöln commercial pound was most generally used for mercantile purposes throughout Northern Europe.

The special requirements of apothecaries' weight do not appear to vary much from those of monetary weight, and hence English Troy weight was apothecaries'

weight for a considerable time; there is, however, one practical requirement of the compounder that calls for attention, the connection between the weight-measures and the capacity-measures. The ounce-weight should be the weight of a fluid ounce of water, and correspondingly also for the dram and fluid dram, grain and fluid grain, and any other such measures. This principle has been admitted in England by the modern adoption of the fluid ounce, and the recent adoption of the liquid grain measure; at present the English apothecaries' system of both weight and measure seems to be resolving itself into the employment of a single unit of weight, the grain weight, and a single unit of measure, the liquid grain, with their decimal multiples—an arrangement that possesses the advantage of extreme simplicity.

The purely commercial weights of almost all nations present a tolerably general similarity. Most nations possess some sort of pound, rotl or catti, or some approximate double-pound, oka, ser, or small *man*; and these form the standard units of which all others are multiples and sub-multiples.

The origin of these pounds was in most cases an Oriental rotl of very ancient date; and it was an unfortunate custom formerly to take the linear square and cubic measures of a nation from one source, while adopting weight-units from another. In other cases the pound is a unit dependent on the weight of water contained in a cubic measure, based on some linear units of national measure, as in the case of the Danish pound, and the Prussian pound, respectively the 62nd and the 66th part of a cubic foot of water of local measure.

The avoirdupois pound falls in the former of these

classes, but its French origin cannot be distinctly assigned ; and as it is not exactly the $\frac{16}{1000}$ of an English cubic foot of water, although nearly so, it is hence a most unfortunate and inexact unit. Even its name, avoirdupois, is not capable of perfect explanation ; from its being mentioned as a haberty-pound, it is supposed to have been a weight used for *averia*, haberties, or movable goods and commodities, in distinction to money and valuables. Its value does not indicate connection with the weights of the *pile de Charlemagne*, or explain its history and derivation. Its utility in England is simply due to the fact that the English are now habituated to a measure of that value ; its historic associations would not be injured by putting it in strict adjustment with cubic measure, and making it exactly the $\frac{16}{1000}$th of a cubic foot ; and the variation introduced would be so small as to be unimportant in the generality of commercial matters, less than $\frac{1}{3}$ per cent.

An English pound on this principle would render the whole English series systematic. Several of the German pounds are degraded values of the ancient and historic unit, the Cöln pound, while others have not their individual origin historically assignable.

The metric pound of France, in use from 1812 to 1840, was a metric approximation to the livre poids de marc, in use before that period, the former being half a kilogramme, 500 grammes ; the latter, 489·5 grammes. This last was divided into 2 marcs, 16 ounces, 128 gros, 384 scrupules or deniers, or 9216 grains, and was supposed to be a unit belonging to the French series, denominated the *pile de* Charlemagne, and based on a yusdruma sent by the Khalif Almamun to Charlemagne. The actual *livre esterlin* of Charlemagne is reputed to

have had a value of 367·1 grammes, or $5666\frac{1}{4}$ English grains, and to have been in value $1\frac{1}{2}$ marc of the French monetary system in the middle ages.

On referring to the tables of former Italian pounds, it will be noticed that some of them either are avowed *rottoli* or happen to be indiscriminately termed *libbre* or *rottoli*, while the same principle holds with pounds of the Levant and the Mediterranean. In some of these places, the rottal and the pound preserve some aliquot ratio to each other, but this does not occur sufficiently often for the purpose of drawing any general conclusion. The values of these *rottal*, however, afford useful indication. Apart from one or two very exceptional rottal, such as the very small one of Jidda, the remainder may be divided into two very marked classes, the large ones, of about two English pounds and upwards, and the ordinary ones, about thirty-two in number, that group well together as approximations to the commercial pounds of Northern Europe, and to the avoirdupois pound more specially ; those of the latter group never approximating to the Northern marcs and monetary pounds. There is therefore sufficient reason for supposing that the mercantile pounds of Europe are rottals by origin ; the other alternative is to suppose them to be simply double-marcs, or augmented marcs.

If the marc was the original unit, preserved in value in the form of current money through a barbarous epoch, and the commercial pounds were afterwards formed, when wanted, either by doubling it, or by adding a half to the monetary pound, or augmented marc (both methods being in vogue from Spain to North Germany), the origin of commercial pounds may then be entirely independent of Oriental derivation.

The closeness of value of the ancient Cöln marc—233·8 grammes or 3608 grains Troy—to the Charlemagne marc, 244·7 grammes, places the old French and German pounds in the same category as regards origin, which probably dated from before that period in the earlier ages when France was entirely overrun and occupied by races from Germany. The French monetary pound is historically assumed to have been a *yusdruma* or later Arab pound, and a corresponding connection may also have existed with the German pounds. There is hence just as much reason for believing the 1½-marc units or monetary pounds to have been generally *yusdruma*, as for considering the 2-marc units or commercial pounds to have been *rottals*, in the vast majority of cases; and both of these theories seem equally probable.

The ordinary *rottal* seems to have been very widely adopted eastward as well as westward, going as far as Persia and India, being known still in Maisur and Travancore and Goa; it is also possible that the *tching* of China, known to the English as the *catti*, was also either a rottal or a mina.

The Arab units are believed to have been thus connected :—

1 canthar = 44 oka = 100 rottal = 132 yusdruma.
1 yusdruma = 12 wakia (ounces) = 120 dirhem (drachms).
1 dirhem = 4 obole = 6 danik = 12 kirat (carats) = 48 chabba (grains).

But there were also earlier units of the same name, but diversely derived, and hence of slightly different values; and besides metrologists have different opinions on this particular subject. Taking the accepted value of the

later canthar, the rottal corresponding to it must have been 7 238 English grains, and the yusdruma 5 483 English grains; but the older yusdruma is estimated to have been 5 666 grains, and this is the one that probably was a really ancient *mina*, and not a yusdruma in the strict sense, its antiquity in Almamun's time making it a valuable present to Charlemagne. Without prolonging this subject of endless discussion, it may be noticed that the above-mentioned Arab units of weight appear to have formed the basic units of weight for almost all nations, and to have remained so to the present day, in the same way as the Arabic numerical notation. The exceptional races that have neither an approximate oka, mina, rottal, yusdruma, or a cheki, are comparatively few, and may have some older but more specially local weights. There appears to have been only one fresh point of departure, the *kilogramme des archives* of unknown density; while the few modified pounds of Europe, adapted to local cubic measure of water, corn, or other substance, are probably systematised approximations to former and more ancient pounds of the type of the Arab rottal.

Leaving the pounds and rottoli of Europe for the oka of the Levant, that shows its origin in its name, the *ser* and the *man* (called by the English the seer and the mun or maund) come next in order for consideration. First taking the Persian and present Arab *man*, which is an exceptionally small one of its name, this generally varies from 2 to 7lbs. in value only, being a small multiple of the local rottal; but there are also some double, royal, and special Persian *man* that are mere augmentations on the ordinary value.

The mass of the larger seers, or *ser*, of India seem to

be undoubtedly okas by origin, more especially the typical and common North-Indian seer of 80 rupees, which approximates to the oka in value. Some of the small local and mostly South-Indian seers were probably ancient units of quite another class, belonging to some former régime and older races; these were, in accordance with Oriental custom, kept up and represented by the weight of a certain number of local current coins. The older races and dynasties being driven south by invading races from the north-west and west, the older seers, or *kuchcha ser*, are hence found in Southern India. They are generally nominally based on pagodas, star-pagodas, and curious antique rupees, some of which are mere lumps of pure silver with a just perceptible trace of a stamp of perhaps one letter of the name of some ancient chief.

There is also another very marked distinction to be drawn between the proper or pukka ser of Northern India, and the small or kuchcha ser of Southern India. They are both units of connection between monetary weight and commercial weight, thus corresponding to the marc and monetary pounds of Europe, and hence fall in both categories as far as estimation and numerical calculation is concerned. But the pukka ser of Northern India is fairly employed and adapted to both purposes, so that a seer of silver, or of oil, grain, or of anything, is an ordinary expression, while the kuchcha ser of Southern India has seldom held so important a position as regards commercial weight, the *viss* of five kuchcha sers there being the distinctive commercial unit. The values of the *viss* are hence given in the following tables in addition to those of the ser, all of which are collected and given together. The *pussurree* or

pasari, the measure of five pukka seers in Northern India, is the unit parallel to the *viss* on the other scale, but is comparatively seldom referred to, being a nominal multiple and not a distinctive unit.

It is this change from the northern *ser* to the southern *viss*, or from a chosen unit of about $2\frac{1}{4}$lbs. corresponding to the Arab oka to another unit of about 3 to $3\frac{1}{3}$lbs. of indigenous origin, that marks an important transition in system of measure. There is also a corresponding transition in civilisation to be noticed in passing from Northern to Southern India, which has earned for the southern provinces the appellation of 'the realms of the benighted.' This expression of the idea may be an exaggeration in language, yet the actual facts not only remain but may be fully accounted for.

Indian civilisation, whether considered semi-civilisation or not, was that of Northern India as regards origin and historic association; the Rajput ascendency, the Brahmanical supremacy, the Buddhist reactionary sway, and the Mughal dominion, each supported a civilisation of their own in Northern India for a considerable period, and with an important amount of homogeneity in each case, before being successively broken up and supplanted.

The Dakhan, Southern India, and the two coasts, never received corresponding advantages to such a widely-spread extent; the Telingi, Tamil, Mahratta, Maisur, and the Haidarabad developments were local and confined round certain centres, while the coasts obtained their enlightenment from a fitful commercial intercourse with distant nations. The permanence and grandeur of the northern civilisation, when pressed southward, was invariably frittered into fractions; while the old substratum of less-expanded and more aboriginal

ideas and customs remained steadfast, and was accompanied by the retention of the older and more primitive measures in the lower part of the peninsula.

Proceeding eastward, the Malayan and Indo-Chinese weights appear to be of an intermediate or mixed type; as the Indian Buddhist exodus took Indian weights further east; while the more purely Malayan races brought Chinese weights westward; some of the weights hence belong to one category, some to the other, as regards origin, although their names may vary considerably.

The Chinese *tching* or pound is the standard unit of weight in China, and is locally peculiar in its subdivision, being divided into 16 liang or ounces; this is in marked contradistinction to Chinese habits of thought, which are rigidly decimal. The Chinese divide anything and everything into *fun*, *li*, *hāo*, and *ssa*, or tenths, hundredths, thousandths, and myriadths, going on further to the infinitely small in the same way. A common fraction is comparatively unknown to them and requires special explanation; such a thing as a sixteenth could hardly have entered their unaided minds; hence the tching and liang must have been importations. Their origin may be a matter of mere surmise, but even this does not offer a very wide range of choice.

The value of the tching, 1·325 lbs., or 9275 grains English, may indicate some Chaldæan or early Egyptian mina of a large and primitive type for its source, but as all trace of sexagesimal subdivision, as well as of decimal subdivision, is missing, this objection seems almost conclusive. In the second place, it may have been an Arab rottal of the larger type introduced with and by the Moslem, and may have followed the same rule as the European commer-

cial pounds, being treated as 16 wakia or ounces, of which about 12 went to the yusdruma, although, as before explained, the rottals were not generally exactly 16 wakia.

Thirdly, the tching may have been a borrowed Dutch commercial pound of 16 ounces, augmented for increased size and consequent imaginary grandeur, while its antiquity may have been an Oriental invention; this origin becomes more probable from the reason that the Chinese itinerary measure the pou of 10 li is believed to be a Dutch league. But the fact that the Chinese *pikul* of 100 tching corresponds proportionately to the Arab canthar of 100 rottal, while also any unit of 10 tching or 10 rottal is entirely absent in both scales, may be considered as evidence that the trio of Chinese weight, pikul, tching, and liang, are derived from the Arab canthar, rottal, and wakia.

The tching, when termed a catti (a word that is not Chinese), is a modified and an export tching used in foreign trade only; the English making it exactly $1\frac{1}{3}$ pounds avoirdupois, the Dutch sometimes $1\frac{1}{4}$ and sometimes $1\frac{1}{5}$ pounds Troy Dutch, the Spaniards 22 Castilian ounces; in these forms it is used all over the Chinese Archipelago and the Indian Ocean, in Borneo Sumatra, and Malacca.

The Japanese have a national picul, tching, and liang of their own, that probably were borrowed from China and afterwards varied from accidental fluctuation of standard.

Large Units.—The larger measures of weight among almost all nations are multiples of their standard units, the pounds, rottals, sers, okas, viss, and tching; and hence require but little comment. The values of

the stone, being dependent on those of the smaller units, may be obtained by applying the ratios given in the tables. The European liespfunds are units of this class.

The Indian dharri is a stone; it is invariably a quarter of a maund, but varies from 6 to 15 pounds in value.

In Turkey, Syria, Arabia, and Persia the man or batman is generally a small unit corresponding to the stone.

In Malacca, the capin of 10 vis is a unit near the value of an English foot-weight or talent.

The English foot-weight, of 1 000 millesimal ounces or 62·321 lbs. av., may be considered an approximate half-hundredweight, essentially necessary in the systematisation of the English system. (See Scientific Systems.)

The values of the centners, centals, quintals, and hundredweights of Europe are given in the tables, as well as their ratios to their corresponding standard units. The English cental of 100 pounds is gradually gaining ground on the hundredweight of 112 pounds in external commerce, and may possibly altogether replace it for such purposes; in the meantime it would be perhaps premature to imagine it has done so, and to give all tabular values in centals instead of in hundredweight.

Perhaps the most convenient mode of arranging the upper English weight-units would be to abolish both the hundredweight and the cental, and use the foot-weight or talent of 62·321lbs. as the standard unit, with a unit of 40 foot-weight as a ton; thus preserving correspondence with cubic measure and the tun of capacity.

The Levantine and Syrian cantaro is either 44 okas or 100 rottal, according as the oka or the rottal is con-

sidered the standard unit; in some cases both ratios are preserved. The Cairene canthar of 36 okas and of 100 local rottal is an exceptional case, probably due to the incorporation of older local measures with the Arab system.

In Northern India, the large mun, or maund, not to be confounded with the small Arab and Persian mun, is a multiple of the proper ser, being almost invariably 40 ser, or about 90 English pounds. In Central India, the Malwah mun are rather small, from 16 to 28 ser and upward; but in this province the māni of 12 mun, varying from 3 to 5 English hundredweight, are the peculiar units; in one or two cases they are merely 4 mun.

In Southern India the mun is comparatively small in value, for it generally consists of 40 nominal or kuchcha sers, which, as before explained, are usually small; the Gujrat mun is small, but here the mauni of 12 mun, or 480 local ser, varying from 4½ to 6 English hundredweight, is also a peculiar local unit. The Malabar, Ganjam, and Travancore mun are small; the more notable of the exceptional South Indian mun are the Bangalore mun of 24 rottal, the Travancore mun of 25 rottal, the Goa mun of 24 rottal, the Tranquebar mun of 68 Danish pounds, and the maunds of Allepay, Quiloa, and Trevandrum of 25 and of 30 olundas or Dutch pounds.

In Southern India besides the maund there is also the kandi or candy, a unit much more frequently employed in all transactions than the maund, in the same way as the viss is more usually adopted than the seer. The kandi is 20 small *man*, and varies from 500 to 560 English pounds; it is hence the large commercial unit in common use, corresponding to the *bahar* of China,

Malacca, and the Malayan Archipelago, and it occasionally takes the latter name.

The bahar of modern Arabia varies much in value; the bahar of China and Malacca is 3 piculs or 300 tching or catti.

Tons and lasts.—The very large or nominal measures of weight corresponding to the English ton are units adopted only by nations having extensive commercial transactions; the number of various tons used in the world is hence comparatively small, as may be seen from the list of them given with their values in the tables at the end of this chapter.

Lasts of freight vary much with the nature of merchandise; although those used for heavy goods are well-defined and invariable.

Units far beyond the ton in value are few in number. The South American cajon for minerals, a case or chest of 50 quintals, or about two English tons (see the tables) is one of these; the Russian perma of four Russian tons or eight packen, used for hay and similar goods, is another; but the whole series of Malwah maniasa of 100 mauni exceed them; the highest being that of Bhopal; their values range from 15 to 25 English tons, and they indicate a high degree of commercial development in the land of opium.

COMMERCIAL POUNDS AND ANALOGOUS UNITS.

GENERAL VALUES.	English Commercial Equivalent. Lbs. av.	English Scientific Equivalent. Ounces	French Scientific Equivalent. Kilog.
England and America: the avoirdupois pound = 16 ounces = 7000 grains troy = 128 medicinal drams = 256 commercial drams	1	16·019	0·45359
An English pound = 16 millesimal ounces, each $\frac{1}{1000}$th of the English foot-weight of water on the scientific series = 16 000 mils = 16 000 000 doits	0·9988	16	0·45304
Denmark: the Danish pound = $\frac{1}{62}$nd part of a foot-weight of water at ordinary temperature = 2 marcs = 16 ounces = 32 lod = 128 qwintin = 512 ort	1·1010	17·637	0·49940
Norway: the Danish pound, but valued thus according to Warden's Report for 1874–75	1·0981	17·591	0·49810
Sweden: the skålpund = 16 ounces = 32 lod = 128 qwintin = 8848 ass; (detached unit)	0·9337	14·958	0·42354
Prussia: the Prussian pound = $\frac{1}{66}$th part of a foot-weight of water in vacuo at 15° Réaumur = 2 marcs = 16 ounces = 32 loth = 128 quentchen = 512 pfennige; the half pfennig being also termed a heller	1·0311	16·518	0·46771
Austro-Hungarian Imperial pound = 4 vierling = 16 ounces = 32 loth = 128 quentchen = 512 pfennige; (detached unit)	1·2347	19·779	0·56006
German Zoll-pound (metric) = ½ kilogramme de la Conservatoire	1·1023	17·658	0·5
Russian Imperial pound (funt) = 12 lana = 16 ounces = 96 sol = 9216 doli; (detached unit)	0·9028	14·463	0·40952
France, Italy, and the Netherlands, &c.: the kilogramme = 1 cubic decimetre of water at 0·4° Centigrade = 1000 grammes	2·2046	35·317	1
Spain: the Castilian pound = 2 marcos = 16 onzas = 128 ochavas = 256 adarmes = 768 tomines = 9216 granos; (detached unit)	1·0141	16·246	0·46000

COMMERCIAL POUNDS, &c.—*continued.* GENERAL VALUES—*continued.*	English Commercial Equivalent. Lbs. av.	English Scientific Equivalent. Ounces	French Scientific Equivalent. Kilog.
Portugal: arratel or arrate = 2 marcos = 4 quartas = 16 onzas = 128 outavas = 384 scrupulos = 9216 graos; (detached unit) . .	1·0119	16·210	0·45900
Ottoman Empire: the Stambul oka = 4 cheki = 400 dirhem = 6400 kirat or taim = 25600 taim; (detached unit)	2·8283	45·308	1·28290
Also the Stambul rotal or lodar = 176 dirhem .	1·2444	19·935	0·56447
Greece: the oka = 400 drachmata . . .	3·3711	54·003	1·52910
Syria: the Damascus rotal = 60 wakia = 400 mitkal = 600 dirhem	3·9544	63·347	1·79370
Arabia: mekka rotal	1·0206	16·349	0·46294
Egypt: Cairo oka or harsela = 400 darham .	2·7769	43·704	1·25960
Abyssinia: rotal or litre = 10 mocha = 120 darham = 12 wakia	0·6857	10·985	0·31104
Tunis: rotal = 16 wakia = 128 mitkal . .	1·1104	17·788	0·50366
Algiers: rotal-attari = 16 wakia . . .	1·2039	19·286	0·54608
Morocco: rotal	1·1123	17·819	0·50454
Persia: the saddarham = 6⅔ giya = 8 danar = 16 pinar = 20 seritahrán = 100 darham = 320 miskal	3·2508	52·076	1·47456
Persia: rotal = 100 miskal	1·0159	16·274	0·46080
Northern India: the Imperial ser or seer = 16 chattak = 80 tola or rupis = 14400 grains troy	2·0571	32·954	0·93311
Also the French kilogramme	2·2046	35·317	1
Southern India: the Madras vis = 50 ounces avoirdupois	3·1250	50·060	1·41748
Also the Bombay ser = 30 paise = 4900 grains troy	0·7	11·214	0·31752
Burma: the Rangun vis = 100 tical . .	3·3333	53·398	1·51198
Thai (Siam) chang = 80 bat = 20 tael . .	2·675	42·852	1·21336
Malacca tampang, or Dutch catti = 1¼ lbs. Dutch troy	1·3564	21·729	0·61525
Sumatra: the English catti	1·3333	21·359	0·60479
Java, Celebes, and Borneo: the Dutch catti .	1·3564	21·729	0·61525
Mindanao and Sulu Islands: the English catti	1·3333	21·359	0·60479
Manila: the Spanish catti = 22 onzas españoles	1·3946	22·341	0·63258
China: the tching = 16 liang.	1·3252	21·229	0·60110
,, the export tching or catti = 16 taels .	1·3333	21·359	0·60479
Japan: Japanese king = 160 nomme . .	1·3	20·825	0·58967

NOTE.—These units are detached, when not expressed as cubicised.

COMMERCIAL POUNDS, &c. —*continued.* FORMER, LOCAL, OR SPECIAL UNITS.	English Commercial Equivalent. Lbs. av.	English Scientific Equivalent. Ounces	French Scientific Equivalent. Kilog.
ENGLAND :—			
Former troy and apothecaries' pound[1] = 12 oz. troy = 5760 grains troy = 96 drachms = 288 scruples	0·8229	13·182	0·37324
Old commercial pound used in foreign trade = 16 ounces (7200 grains troy) = 10240 grains.	1·0286	16·477	0·46657
Old merchants' pound = 15 ounces = 25 shillings = 300 pence (6750 grains troy) = 9680 grains	0·9643	15·447	0·43739
Old moneyers' pound[1] = 12 ounces = 20 shillings = 240 pence = $1\frac{1}{2}$ marc = 7680 grains (5400 grains troy)	0·7714	12·358	0·34992
DENMARK AND NORWAY :—			
Monetary pound,[1] for subdivision see commercial pound, also = 8192 as = 63536 grains .	1·0379	16·627	0·47080
SWEDEN :—			
Export pound and jernwigt pound = $\frac{4}{5}$ skålpund	0·7469	11·965	0·33883
Town pound, uppstadswigt = $7450\frac{2}{125}$ ass .	0·7862	12·486	0·3566
Miners' pound, bergwerkwigt = $7821\frac{79}{125}$ ass .	0·8254	13·223	0·3744
Copper pound, råkopparwigt = 7853 ass . .	0·8287	13·275	0·3759
Iron-ore pound, råjernwigt = 10168 ass . .	1·0750	17·189	0·4867
GERMANY :—			
The Prussian pound was used in several additional places after 1816; Weimar, Silesia, Hesse, and Würtemberg. The subdivision of the following German pounds follows the Prussian type except when otherwise expressed. (See General Values.). . .	1·0311	16·518	0·46771
The Cöln pound used in Saxony, Lippe-Detmold, and at Hamburg for retail trade .	1·0307	16·511	0·46750
Baden, after 1810, zoll-pfund = 10 zehnling = 100 centass = 1000 pfennige = 10000 as ; also divided into 32 loth = 128 quentchen . .	1·1023	17·658	0·5
Bavaria, from 1810 to 1872, pound = 16 unzen = 32 loth = 128 quentchen	1·2346	19·777	0·56000
Bremen pound	1·0985	17·596	0·49825
Brunswick pound	1·0302	16·503	0·46730
Coburg pound	1·1239	17·994	0·50980
Darmstadt, zoll-pfund = 32 loth = 128 quentchen = 512 richtpfennige	1·1023	17·658	0·5
Elsass, livre poids de marc (see France) . .	1·0792	17·288	0·48951

[1] Monetary pounds were used for some purposes in retail trade.

COMMERCIAL POUNDS, &c. —*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Lbs. av.	Ounces	Kilog.
GERMANY—*continued*:—			
Elsass, old pfund of Elsass for retail trade	1·0395	16·652	0·47150
Frankfurt-on-the-Main, wholesale pound	1·1140	17·846	0·50530
,, ,, ,, retail pound	1·0315	16·524	0·46787
Gotha pound	1·0304	16·507	0·46740
Hamburg, wholesale lb. is the Holstein lb.	1·0679	17·107	0·48440
,, retail pound is the Cöln pound	1·0307	16·511	0·46750
Hanover pound	1·0794	17·291	0·48960
Holstein pound	1·0679	17·107	0·48440
Lübeck pound	1·0684	17·114	0·48460
Mecklenburg Schwerin, wholesale pound as at Hamburg	1·0679	17·107	0·48440
,, ,, retail lb., aug. 5 per ct.	1·1213	17·962	0·50860
Nassau, the Wiesbaden pound	1·0377	16·624	0·47070
Nuremberg, old commercial pound	1·1244	18·012	0·51000
,, old monetary pound	1·0518	16·850	0·47710
Oldenburg, the Hamburg pound subdivided down to 8192 as	1·0679	17·107	0·48440
SWITZERLAND:—			
The three pounds most commonly used were—			
Zoll-pfund	1·1023	17·658	0·5
Uri, Zug, Zurich, Schwytz & Glaris } Zurich heavy pound = 18 oz.	1·1654	18·668	0·5286
Uri, Zug, Zurich, Schwytz & Glaris } Antorf light pound = 16 oz.	1·0357	16·592	0·4698

Arau pound = 32 loth	1·0507	16·832	0·4766
Basel, wholesale or heavy pound = 16 ounces	1·0873	17·418	0·4932
,, retail pound = 16 ounces = 32 loth = 128 quentchen	1·0719	17·171	0·4862
,, monetary pound (Prussian) = 16 ounces	1·0311	16·518	0·4677
Berne and Neufchâtel, heavy pound = 16 ounces	1·1466	18·368	0·5201
,, ,, light lb. (Fr. p. de marc)	1·0792	17·288	0·4895
Freiberg, commercial pound = 32 loth = 128 quentchen	1·1654	18·668	0·5286
,, monetary pound (French p. de marc)			
St. Gall, heavy pound = 20 ounces = 40 loth	1·2733	20·397	0·57755
,, light pound = 16 ounces = 32 loth	1·0252	16·422	0·4650
Geneva, heavy pound = 18 oz. = 432 pfennige	1·2141	19·449	0·5507
,, light pound = 15 ounces = 360 pfennige	1·0117	16·207	0·4589
Grisons, meat pound = 48 loth	1·5296	24·493	0·6938
,, fish pound = 36 loth	1·1471	18·375	0·5203
,, light pound = 32 loth	1·0196	16·334	0·4625
Lucerne, pound = 36 loth = 144 quentchen	1·1010	17·637	0·4994
Schaffhausen, heavy pound = 40 loth	1·2677	20·307	0·575
,, light pound = 32 loth	1·0141	16·246	0·460
Thurgau, Appenzell heavy lb. = 20 oz. = 40 loth	1·2888	20·646	0·5846
,, ,, light lb. = 16 oz. = 32 loth	1·0252	16·422	0·465

COMMERCIAL POUNDS, &c. —*continued.*	English Commercial Equivalent. Lbs. av.	English Scientific Equivalent. Ounces	French Scientific Equivalent. Kilog.
SWITZERLAND—*continued* :—			
Ticino, libbra grossa = 32 ounces = 64 loth .	1·9421	31·110	0·8809
,, libbra sottile = 12 ounces = 24 loth .	0·7283	11·667	0·33035
Waadt, since 1822, pound = $\frac{1}{54}$th part of a foot-weight of water at 39° Fahr. = 16 oz. = 128 gros = 512 pfennige = 9216 grains . .	1·1023	17·658	0·5
NOTE.—The ounces of the light and heavy pounds are not necessarily identical at any one place or canton.			
FRANCE :—			
Livre métrique (1812 to 1840) = ½ kilogramme = 16 onces = 128 gros = 9216 grains . .	1·1023	17·658	0·5
Livre poids de marc = 2 marcs = 16 onces = 128 gros = 9216 grains	1·0792	17·288	0·48951
Livre esterlin = 1½ marc = 12 onces = 20 sous = 24 deniers = 4800 oboles = 5760 grains . .	0·7093	12·965	0·3671
HOLLAND AND BELGIUM :—			
Amsterdam pond = 16 onsen = 32 looden = 128 drachms = 10280 as	1·0893	17·451	0·49409
Troy-pond, subdivided in the same way, but also = 320 engeln = 10240 as	1·0850	17·382	0·49216
Brussels shop-pound = 4 quarter = 16 onsen = 64 satin = 128 gros = 9216 grains . . .	1·0311	17·220	0·46770
AUSTRO-HUNGARY :—			
The Imperial and the Zoll-pound (*General Values*).			
Bohemian old pound	1·1342	18·169	0·51445
Buda-Pesth, old pound	1·0576	16·941	0·4797
Galicia, old Lemberg pound	0·9262	14·836	0·4201
Cracow pound = 2 marc = 16 ounces = 32 loth = 48 skoykiecs	0·8949	14·335	0·4059
Silesian old pound (subdivided as at Vienna) .	1·1676	18·704	0·5296
Dalmatia, Ragusa pound = $\frac{2}{7}$ oka = 12 ounces = 120 drachms	0·8437	13·516	0·3827
Illyria, funto of Fiume	1·2317	19·731	0·5587
Tyrol, Tyrolese pound = 16 ounces = 32 loth .	1·2403	19·869	0·5626
,, Trent commercial pound . . .	0·7408	11·866	0·336
,, Botzen heavy pound	1·1045	17·693	0·501
,, Botzen light pound for grocery . .	0·7290	11·678	0·33065
RUSSIA :—			
Imperial, commercial, and monetary (*General Values*).			
Old Lithuanian pound	0·8261	13·233	0·3747
Narva pound = 96 solotnik	1·0318	16·528	0·468

COMMERCIAL POUNDS, &c. —*continued.* RUSSIA—*continued* :—	English Commercial Equivalent. Lbs. av.	English Scientific Equivalent. Ounces	French Scientific Equivalent. Kilog.
Pernau pound = 16 oz. = 32 loth = 128 quenten	0·9185	14·713	0·4166
Revel ,, ,, ,, ,,	0·9502	15·221	0·431
Riga	0·9217	14·764	0·41805
Warsaw, metric funt = 16 ounces = 32 loth = 48 skoykiecs = 9216 granikow of 8 milligrams .	0·8940	14·321	0·4055
,, ancient funt before 1819 . . .	0·8352	13·379	0·37885
ITALY :—			
Libra metrica (since 1803) = 10 oncie = 100 grossi = 1000 denari = 10000 grani . .	2·2046	35·317	1
Ancona, lira commerciale = 12 oncie . .	0·7293	11·683	0·3308
Belluna, libbra peso grosso	1·1391	18·248	0·5167
,, ,, sottile	0·6640	10·637	0·3012
Bergamo, lira = 30 oncie = 720 denari = 17280 grani.	1·7973	28·792	0·81525
Bergamo, liretta = 12 oncie = 288 denari = 6912 grani.	0·7189	11·517	0·3261
Bologna, libbra = 12 oncie = 96 ottave = 192 ferlini = 1920 carati = 7680 grani . . .	0·7981	12·785	0·3620
Brescia, libbra commerciale	0·7077	11·337	0·3210
Como, libbra	0·6839	10·955	0·3102
Cremona, libbra commerciale	0·6812	10·913	0·3090
Ferrara ,, ,, = 12 oncie . .	0·7625	12·214	0·34585
,, the monetary pound was that of Rome.			
Genoa, peso grosso = 12 oncie	0·7686	12·313	0·34865
,, libbra peso scarso = $\frac{2}{5}$ rottolo = 12 oncie	0·6989	11·195	0·3170
Messina and Palermo } rottolo ordinario = 30 oncie .	1·7502	28·037	0·79388
Messina and Palermo } monetary libbra = 12 oncie = 360 trapesi	0·7072	11·328	0·32076
Milan, libbra peso grosso = 4 quarti = 28 oncie	1·6811	26·931	0·76255
,, ,, ,, sottile = 12 oncie = 6912 grani	0·7205	11·542	0·3268
Modena, lira = 12 oncie = 192 ferlini . .	0·7500	12·015	0·3402
Monetary pound was that of Bologna.			
Naples, rottolo of commerce = $2\frac{7}{9}$ lbs. = $33\frac{1}{3}$ oncie	1·9643	31·467	0·891
Naples, monetary libbra = 12 oncie = 360 trapesi = 7200 acini	0·7072	11·328	0·32076
Padua and Vicenza } libbra peso grosso = 12 oncie .	1·0726	17·182	0·4865
Padua and Vicenza } ,, sottile = 12 ,, .	0·7472	11·969	0·3389
Parma, libbra = 12 oncie = 288 denari = 6912 grani	0·7196	11·527	0·3264
Piacenza, libbra = 12 oncie = 288 denari = 6912 grani	0·7011	11·231	0·3180
Piedmont, Turin libbra = $1\frac{1}{2}$ marc = 12 ounces = 96 ottavi = 6912 grani = 165888 granatini .	0·8131	13·027	0·36885

COMMERCIAL POUNDS, &c. —*continued.* ITALY—*continued* :—	English Commercial Equivalent. Lbs. av.	English Scientific Equivalent. Ounces	French Scientific Equivalent. Kilog.
Reggio, libbra	0·7165	11·477	0·3250
Rome ,, = 12 oncie = 288 denari = 6912 grani	0·7476	11·976	0·3391
Rovigo, libbra peso grosso	1·0523	16·857	0·4773
,, ,, ,, sottile	0·6645	10·644	0·3014
Sardinia ,, = 12 oncie	0·8963	14·356	0·4065
Sicily, Neapolitan pound = 12 oncie	0·7072	11·328	0·32076
,, old Sicilian pound = 12 oncie = 5760 cocci	0·7001	11·215	0·31755
Tuscany, libbra = 12 oncie = 96 drachme = 6912 grani	0·7486	11·992	0·33955
Tuscany, Livorno rottolo = 3 libbre = 36 oncie	2·2457	35·975	1·01865
Venice, libbra peso grosso = 2 marc = 72 sazi = 2304 carati	1·0517	16·848	0·47705
Venice, libbra peso sottile = 12 oncie = 72 sazi = 1728 carati	0·6643	10·641	0·3013
Verona, libbra peso grossò = 12 oncie = 192 mezetti	1·1019	17·651	0·4998
Verona, libbra peso sottile = 12 oncie = 192 mezetti	0·7346	11·768	0·3332
SPAIN :—			
Castile and Leon, libra castillana (general)	1·0141	16·246	0·4600
Aragon, libra pensil = $1\frac{1}{2}$ marcos = 12 onzas = 48 quartos = 192 adarmes = 6144 granos	0·7716	12·361	0·3500
Asturias, libra mayor = 3 marcos = 24 onzas cast.	1·5212	24·369	0·6900
,, ,, menor = libra castillana.			
Cataluña, Majorca and Minorca, libra = $1\frac{1}{2}$ marcos = 12 onzas = 48 quartos = 192 arienzos = 6912 granos	0·8818	14·127	0·4000
Galicia, libra gruesa or gallega = 20 onzas	1·2703	20·350	0·5762
,, ,, sutil = libra castillana = 16 onzas.			
Grenada, old libra mayor	1·1018	17·649	0·49975
,, ,, menor	0·9793	15·688	0·4442
Iviza, libra	1·0207	16·352	0·4630
Murcia ,,	0·9586	15·356	0·4348
Navarra, libra = 2 marcos = 16 onzas = 17 onzas cast., divided in the Castilian manner	1·0787	17·280	0·4893
San Lucar, libra	1·0450	16·613	0·4704
San Sebastian, libra = 1·06 libra castillana	1·0759	17·234	0·4880
Tortosa (Spain) libra	0·6716	10·759	0·30465
Valencia, libra mayor = 18 onzas	1·1751	18·824	0·5330
,, ,, menor = 12 onzas (Castilian subdivision)	0·7834	12·549	0·35533
Valencia, libra for saffron and chocolate = 16 onzas	1·0445	16·732	0·47377
Valencia for bread and meat = 36 onzas	2·3501	37·648	1·0660
Canary Islands, libra castillana.			

COMMERCIAL POUNDS, &c. —*continued.*	English Commercial Equivalent. Lbs. av.	English Scientific Equivalent. Ounces	French Scientific Equivalent Kilog.
SOUTH AMERICA, MANILA, &c. :—			
The Castilian pound. (See General Values.)			
BRAZIL, MADEIRA, GOA, &c. :—			
The Portuguese arratel. (See General Values.)			
IONIAN ISLANDS, GREECE, &c. :—			
The pound avoirdupois	1	16·019	0·45359
The Venetian libra peso grosso	1·0517	16·848	0·47705
,, marc = ⅔ libra	0·7011	11·232	0·31803
Patras, pound = ⅓ oka = 12 oz. = 133⅓ drachma	0·8810	14·114	0·39963
,, silk pound = 15 ounces	1·1013	17·642	0·49955
Morea, pound = ⅜ oka = Venetian libra p. g.	1·0517	16·848	0·47705
Malta, monetary lira = ⅖ rottolo = 12 oncie	0·6980	11·181	0·31660
INDIA AND THE ANTILLES :—			
Cannanor, pound = 4 pollam = 40 Surat rupis	1·0227	16·383	0·4639
Cochin ,, = 42½ Surat rupis	1·0867	17·408	0·4929
Ceylon, pound avoirdupois	1	16·019	0·45359
Ceylon, formerly the Dutch troy pound	1·0850	17·332	0·49215
Antilles (French) livre poids de marc	1·0792	17·288	0·48951
Curaçao, old pound	1·1713	18·764	0·5313
Saint Croix, the Danish pound	1·1010	17·637	0·4994

The Rotal, Lodar, and Cheki.

For the Italian rottoli see the Italian pounds (p. 216). The Portuguese rotal is given among the General Values.			
Balearic Islands, rottolo = 3 libras = 36 onzas	2·6454	42·381	1·2000
Malta, rottolo = 2½ lire = 30 oncie	1·7450	27·953	0·79150
,, ,, grosso = 2¾ lire = 33 oncie	1·9195	30·748	0·87065
Cyprus ,, = 12 ounces = 750 drachms	5·2441	84·007	2·37868
OTTOMAN EMPIRE AND GREECE :—			
Stambul, rotal or lodar = 176 dirhem	1·2444	19·935	0·56447
,, cheki or yusdruma = 100 dirhem = 1600 karat or taim = 66⅔ mitkal	0·7071	11·327	0·32073
Stambul, opium cheki = 250 dirhem	1·7677	28·317	0·80181
Rhodes, rotolo	5·2744	84·493	2·39245
Scio ,,	1·0925	17·500	0·49553
Candia ,,	1·1656	18·672	0·52869
The Wallachian litre = Stambul cheki			
Patras, rotolo or pound = ⅓ oka	0·8810	14·114	0·39963
Negropont, rotolo	1·1802	18·905	0·53531
Mistra ,,	0·9969	15·969	0·45218
SYRIA :—			
Acra, rotal for raw cotton, and general use	4·8652	77·937	2·20682

COMMERCIAL POUNDS, &c. —*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Lbs. av.	Ounces	Kilog.
SYRIA—*continued*:—			
Acra, rotal for spun cotton	4·4909	71·942	2·03706
Aleppo and Alexandretta, rotal = $1\frac{4}{5}$ oka = 12 ounces = 720 darham	5·0266	80·523	2·28003
Aleppo, rotal for Syrian silk = 700 darham	4·8870	78·286	2·21670
,, ,, Persian ,, = 680 ,,	4·7472	76·049	2·15336
,, ,, drugs = 600 ,,	4·1889	67·103	1·90003
Damascus, rotal = 60 wakia = 400 mitkal = 600 darham	3·9544	63·347	1·79370
Smyrna, rotal or lodar = 180 darham	1·2746	20·419	0·57817
,, cheki = $\frac{1}{4}$ oka = 100 ,,	0·7081	11·344	0·32121
,, opium cheki = 250 ,,	1·7703	28·360	0·80301
Tripoli, small rotal = $1\frac{1}{2}$ oka = 600 darham	4·0053	64·162	1·81677
,, large ,, = $1\frac{4}{5}$,, = 720 ,,	4·8063	76·994	2·18012
Saïd (Sidon), the rotal for ordinary trade	5·2537	84·161	2·38305
,, the silk rotal = 600 darham	4·1081	65·810	1·86342
ARABIA:—			
Mekka and Medina, rotal	1·0206	16·349	0·46294
Mokha, rotal = 15 vakia	1·5	24·029	0·68039
,, coffee rotal = $14\frac{1}{2}$ vakia	1·45	23·228	0·65771
Betelfaghi, rotal = 15 vakia	1·0194	16·330	0·46239
,, coffee rotal = $14\frac{1}{2}$ vakia	0·9854	15·786	0·44698
,, rotal for dates, iron, &c. = 16 vakia	1·0874	17·419	0·49322
Jidda, rotal = 15 vakia	0·3660	5·863	0·1660
EGYPT AND ABYSSINIA:—			
Alexandria, rotal = 144 dirham	0·9678	15·503	0·43897
Cairo, rotal = 12 vakia = 144 dirham	0·9499	15·217	0·43087
Abyssinian rotal or litar = 10 mokha = 12 vakia = 144 dirham	0·6857	10·985	0·31103
BARBARY, TUNIS, AND MOROCCO:—			
Tunis, rotal = 16 vakia = 128 mitkal	1·1104	17·788	0·50366
Tripoli ,, = 16 ,, = 160 darham = 2560 kharuba	1·0970	17·574	0·49760
Fez, rotal	1·0370	16·613	0·47039
Tangiers, rotal	1·0608	16·993	0·48115
Tetuan ,,	1·5635	25·047	0·70921
Morocco, small rotal	1·1123	17·819	0·50454
,, large ,, = $1\frac{1}{2}$ small rotal	1·6685	26·728	0·75681
Mogador, rotal = 20 piastres españoles	1·1865	19·007	0·53818
ALGIERS:—			
Rotal feudi (monetary) = 16 vakia	1·0966	17·568	0·49743
,, attari (ordinary) = 16 ,,	1·2039	19·286	0·54608
,, kebir = $1\frac{1}{2}$ rotal attari = 24 vakia	1·6450	28·929	0·81912
Oran rotal	1·1107	17·793	0·50382

COMMERCIAL POUNDS, &c. —*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
GUINEA :—	Lbs. av.	Ounces	Kilog.
Benda = 8 piso = 16 agirac	0·1414	2·265	0·06412
PERSIA AND INDIA :—			
Persian rotal = 100 miskal	1·0159	16·274	0·46080
Maisur rotal = 40 rupis = $1\frac{2}{3}$ Bangalur ser . .	1·0062	16·118	0·45640
Travancor rotal or putur = $\frac{1}{20}$ tulam . .	0·9959	15·954	0·45173
,, another rotal = $\frac{1}{25}$ man . . .	1·0010	16·035	0·45403
,, Colachi rotal = 5 pollam = 1350 manjandi	0·7521	12·048	0·34113
EASTERN ASIA :—			
The Tching or Catti.			
China, tching = 16 liang = 160 tchen = 1600 fun = 16000 li	1·3252	21·229	0·6011
China, export tching, or Anglo-Chinese catti = 16 tael = 160 maces = 1600 condorin = 16000 cash : also for Japanese export . . Used also at Singapur, Sumatra, Camboja, Moluccas, Mindanao, and Sulu Islands .	1·3333	21·359	0·6048
Dutch-Chinese catti = $1\frac{1}{4}$ pounds, Dutch troy, used in Sumatra, Borneo, Java, Celebes, and Malacca : also termed a tampang . .	1·3564	21·729	0·6153
Hispano-Chinese catti = 22 onzas españoles, used at Manila, and in the Philippines .	1·3946	22·341	0·6326
Malacca, catti = 16 tael	1·3500	21·626	0·6124
Molucca catti = $1\frac{1}{5}$ lbs. Dutch troy (Amboyna) .	1·3022	20·860	0·5907
Queda, catti	1·6211	25·969	0·7353
Anam, kan = 16 luong = 160 dong . . .	1·3750	22·027	0·6237
Mocamoco, catti = 16 tael = 24 ringit . .	1·4583	23·361	0·6615
Acheen, catti = 20 bunkal = 100 tael . .	2·1171	33·915	0·9603
Malacca, monetary catti = 20 bunkal . .	2·0491	32·825	0·9295
Singapur ,, = 20 ,, . .	2·3768	38·075	1·0781
Japan, king = 160 nomme	1·3000	20·825	0·5897
,, the king is also estimated to be equal to the Anglo-Chinese catti			
Thai (Siam), chang or ching = 80 bat . .	2·6750	42·852	1·2134
Manila, the tola for gold = 10 piastres . .	0·5966	9·558	0·2706
,, ,, ,, silk = 11 piastres, or ounces	0·6563	10·513	0·2977

ORIENTAL DOUBLE POUNDS.

The Oka, Okijah, and Large Wakia.

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Lbs. av.	Ounces	Kilog.
EASTERN EUROPE :—			
Hungarian oka = $2\frac{1}{4}$ pounds = 400 dirham .	2·7778	44·499	1·2600
Moldavian, or Galatz oka	2·8660	45·912	1·3000
Wallachian, or Ibrahil oka	2·8660	45·912	1·3000
Dalmatian, or Ragusa oka = $3\frac{1}{2}$ pounds = 42 ounces = 420 drachms	2·9527	47·300	1·3393
Ionian Islands, oka = 2·7 lbs. = 400 drachms .	2·7	43·252	1·2247
Cyprus, oka = 400 drachms	2·7968	44·803	1·2686
TURKEY :—			
Stambul, oka = 4 cheki = 400 dirham . .	2·8283	45·308	1·2829
Candia, oka = $2\frac{3}{11}$ rotal = 400 drachms . .	2·6491	42·436	1·2016
GREECE :—			
Greek oka = 400 drachms	3·3711	54·003	1·5291
Patras and Morea, oka = 3 pounds = 36 ounces = 400 drachms . . . . } Also the Stambul oka . . . . . }	2·6431	42·341	1·1989
SYRIA :—			
Aleppo, oka = 400 drachms	2·7925	44·734	1·2667
Smyrna ,, = 4 cheki = 400 drachms . .	2·8325	45·375	1·2848
Tripoli ,, = 400 drachms	2·6702	42·775	1·2112
MESOPOTAMIA :—			
Bagdad and Bussàra, oka = 400 drachms .	2·7425	43·934	1·2440
Bassara, wakia	4·8328	77·418	2·1921
,, wakia-attari	1·1665	18·686	0·5291
EGYPT AND BARBARY :—			
Alexandrian oka = 400 drams	2·7282	43·704	1·2375
Cairo, oka or harsela = $2\frac{7}{9}$ rotal = 400 drams .	2·7769	44·485	1·2596
Tripoli, oka = $2\frac{1}{2}$ rotal = 400 darham . .	2·7425	43·934	1·2440
PERSIA :—			
The Saddirham = 8 danar = 100 dirham . .	3·2508	52·076	1·4746
Persian wakia = 90 miskal = 4 nimmih . .	0·9143	14·646	0·41472

The Ser, or Seer.

Indian Imperial ser = 16 chattak = 80 rupis weight = 14400 troy grains	2·0571	32·954	0·9331
A double pound of 32 millesimal ounces of the English scientific series	1·9976	32	0·906
The French kilogramme (used as a ser) . .	2·2046	35·317	1

ORIENTAL DOUBLE POUNDS —*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
NORTH INDIAN UNITS (or proper sers) :—	Lbs. av.	Ounces	Kilog.
Allahabad and Lakhnau, ser = 96 sicca	2·4640	39·473	1·1177
Balasur (Orissa), ser = 16 chattak	1·8906	30·288	0·8576
Bauleah and Serampur, ser = 16 chattak = 60 Bengal sicca	1·5400	24·666	0·6984
Banaras, ser of 105 rupi of Benares	2·6250	42·050	1·1907
,, ,, 96 ,, ,,	2·4000	38·446	1·0886
Bhopal (Malwa) ser = 80 rupi	1·9286	30·895	0·8748
Calcutta, bazar ser	2·0533	32·892	0·9314
,, factory ser = 80 sicca = 16 chattak	1·8667	29·903	0·8467
Calpī and Etawah (Agra) ser = 16 ,, } ,, Khaus-ser for sugar and metal	2·1211	33·978	0·9621
,, Raipur-ser, retail	2·3750	38·046	1·0773
,, ,, wholesale	2·5313	40·550	1·1482
Dakka, ser = 16 chattak	2·0469	32·790	0·9285
Hughli ,, = 16 ,,	2·1047	33·716	0·9547
Indor ,, = 82 Ujjain rupi	2·0266	32·387	0·9193
Malda ,, = 100 Bengal sicca	2·5625	41·050	1·1624
Malwah, or Bunswara ser = 84 Salimshahi rupi	2·0250	32·439	0·9185
Mirzapur, ser = 84 Bengal sicca	2·1560	34·538	0·9780
Patna, many ser units, the principal one is ser = 80 sicca	2·0566	32·945	0·9329
Pertabghur, ser = 80 Salimshahi rupi	1·9286	30·895	0·8748
Ujjain, ser = 80 rupis = 16 chattak	1·9771	31·672	0·8968
SOUTH INDIAN UNITS (mostly kachcha sers) :—			
Ahmadnagar, commercial ser = 80 Ankosi rupi	1·9714	31·577	0·8941
,, goldsmiths' ser = 24 tola	0·6453	10·337	0·2927
Bangalur, kachcha ser = 24 Arcot rupi	0·6035	9·668	0·2738
,, pakka ser = 84 ,,	2·1132	33·852	0·9585
Ballari, commercial ser = 21 Maisur rupi	0·5288	8·471	0·2399
Baroda, ser = 42 Babashahi rupi	1·0620	17·009	0·4816
Belgaum and Shahpīr, ser = 24 Shahpīr rupi	0·5966	9·557	0·2706
Bombay goldsmiths' ser = 24 tola	0·6137	9·831	0·2784
,, and Surat, commercial ser = 30 paise (pice)	0·7	11·212	0·3175
Haidarabad, Dakkan, ser = 80 rupi	1·9851	31·800	0·9004
Madras, native ser = 80 pagoda = 8 pollam	0·6028	9·657	0·2734
Anglo-Madras ser = 10 ounces avoirdupois	0·6250	10·012	0·2835
Puna, commercial ser = 72 tola	1·9714	31·577	0·8941
Telicherri and Calicut, ser = 20 Surat rupi	0·5114	8·192	0·2320
Trichinopalli, metal ser	0·5954	9·538	0·2701
,, retail ,, = 243 star pagodas	1·9060	30·533	0·8645
,, wholesale ser = 270 star pagodas	2·1178	33·926	0·9606

ORIENTAL TRIPLE-POUNDS.

The Vis, Panj-ser, or Passari.

The panj-ser of Northern India is a mere term for 5 proper sers. The passari of Central India is generally 5 sers, but at Bhilsa is 6 sers, at Bhopal 6½ sers, and at Omutwara is 3½ sers.

	English Commercial Equivalent. Lbs. av.	English Scientific Equivalent. Ounces	French Scientific Equivalent. Kilog.
SOUTHERN INDIA :—			
Bangalur, vis = 5 ser kachcha	3·0189	48·361	1·3694
,, ,, = 5¼ ,, ,,	3·1698	50·778	1·4378
Ballari, panchaser = 6 ser	3·1725	51·025	1·4390
Seringapatam, panchser = 5 ser	3·0343	48·608	1·3763
Surat, panseri = 5 ser	4·6875	75·091	2·1262
Madras, indigenous vis = 400 pagodas = 5 ser	3·0143	48·287	1·3673
,, Anglo ,, = 5 ser = 50 ounces av.	3·1250	50·060	1·4175
Masulipatam, vis = 5 ser = 450 pagodas	3·5156	56·318	1·5947
Pondicherri ,, = 3 pounds, poids de marc	3·2379	51·853	1·4682
Trichinopalli ,, = 5 (metal) ser, nearly	3	48·058	1·3608
BURMA AND MALACCA :—			
Rangun, vis = 100 tical = 10000 mus	3·3333	53·398	1·5120
Pegu ,, = 100 ,, = 10000 ,, = 4 agito = 8 abuco = 450 pagodas	3·3929	54·352	1·5390
Tocopa, vis = 4 put = 12 pinga	5·9500	95·315	2·6989
Janselon, vis = 4 put	6·0667	97·184	2·7518
SUMATRA &c. :—			
Sinkel, catti-utan = 3 English cattis	4	64·077	1·8144
,, ,, for camphor	3·8400	61·514	1·7418
,, ,, for benzoin	3·50	56·068	1·5876
Banda ,,	6·10	97·721	2·7669

THE STONE AND THE LIESPFUND.

Ratios to the Commercial Pound for both General and Former Local Units.

	Local lbs.
England : ordinary stone	14
,, For meat or fish	8
,, For glass	5
Denmark, Norway } lispund	16
Sweden : sten	32
,, lispund for iron	16
,, ,, or ordinary	20
GERMANY :—	
Berlin, stein, light	11
,, ,, heavy	22
GERMANY—*continued* :—	
Berlin, liespfund	16½
,, ,, formerly	14
Baden, stein	10
Bavaria ,,	20
Bremen ,, light (wool)	10
Bremen, stein, heavy (flax)	20
,, liespfund (light)	14
,, ,, (heavy)	14½
Breslau, stein	22
,, laep	24
Brunswick, stein,	10, 11, 20 or 22

THE STONE AND THE LIESPFUND—*continued.*

	Local lbs.
GERMANY—*continued* :—	
Brunswick liespfund . .	14
Cassel, kleuder (wool) . .	21
Danzig, stein (sugar, rice, sirup)	22
,, ,, (flax, hemp, cord)	33
,, liespfund (Prussian).	
Frankfurt on Main, stein .	22
Hamburg, stein (flax) . .	20
,, ,, (wool, feathers)	10
,, liespfund . . .	14
,, ,, (freight) .	16
Hanover, stein (wool) . .	10
,, ,, (flax and hemp)	20
,, liespfund . . .	14
Holstein ,, ...	14
Kœnigsberg, stein (light) .	20
,, ,, (heavy) .	33
,, liespfund, Prussian.	
Lübeck, stein (wool, feathers) .	10
,, ,, (flax) . .	20
,, liespfund (ordinary) .	14
,, ,, (freight) .	16
Mecklenburg, stein (light) .	11
,, ,, (heavy) .	22
,, liespfund (ordin.)	14
,, ,, (freight)	16
Oldenburg, stein (wool, feathers)	10
,, liespfund . .	$14\frac{1}{2}$

	Local lbs.
GERMANY—*continued* :—	
Oldenburg stein (flax) . .	20
Saxony, stein	22
SWITZERLAND :—	
Zug, stein	$4\frac{1}{2}$
HOLLAND AND BELGIUM :—	
Amsterdam, steen . . .	8
,, lyspond . .	15
Brussels, sten	8
AUSTRO-HUNGARY :—	
Vienna, stein	20
,, ,, (also) . .	22
Bohemia ,, ...	20
Cracow, kamieneck . .	25
,, ,, (old) .	32
,, ,, (also) .	24
RUSSIA :—	
Imperial pud in Imperial funt .	40
Local pud in local funt . .	40
Warsaw, kamieneck . .	25
,, ,, (wool) .	32
Narva, liespfund . . .	20
Pernau ,, ...	20
Riga ,, ...	20
Revel ,, ...	20

The values may be reduced from those of the pounds.

ORIENTAL STONES.

The Smaller Mun, Man, or Batman.

OTTOMAN EMPIRE :—

Turkish and Syrian man = 6 local oka.
Arabian man, generally = 2 ,, rotal.
But the Jidda man = 5 Jidda rotal.

PERSIA :—

Man i tabriz = 40 sir i tahran = 640 miskal .	6·5017	104·153	2·9491
,, shiraz = 60 ,, shiraz = 720 ,, .	7·3144	117·172	3·3178
,, bushahr = 16 giya = 768 ,, .	7·8020	124·983	3·5389
,, shah = 4 saddirham = 400 dirham .	13·0034	208·306	5·8982

INDIA :—

The Dharri or Dhaddā.

The dharrī or dhaddha is an expression for the quarter of an Indian man or mun ; the dassari is ten seers.

QUARTERS AND ANALOGOUS UNITS.

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
England and America :—	Lbs. av.	Fwt.	Kilog.
The English quarter (weight-unit) is the quarter of the hundredweight. The American quarter (weight-unit) is the quarter of the cental.			
England : the quarter	28	0·4485	12·701
America : ,, ...	25	0·4005	11·340
The half of the commercial talent or foot-wt. .	31·161	0·4992	14·134
The half of the talent or foot-weight of the Scientific series	31·212	0·5	14·158
The arroba.			
Spain :—			
The Spanish arroba (weight-unit) is the quarter of the quintal.			
Castilian arroba = 25 libras castillañas . .	25·353	0·4061	11·500
Alicante ,, ordinaria = 36 libras menores	28·254	0·4526	12·816
,, ,, granesa = 30 ,,	23·545	0·3772	10·680
Aragon ,, = 36 libras menores . .	27·778	0·4450	12·600
Cataluña ,, = 26 ,, ...	22·928	0·3673	10·400
Galicia ,, = 25 ,, gallegas . .	31·758	0·5088	14·405
Valencia ,, ordinaria = 36 libras menores	28·254	0·4526	12·816
,, ,, delgada = 30 ,,	23·545	0·3772	10·680
,, ,, (for flour) = 32 ,,	25·115	0·4023	11·392
Canaries ,, = 25 libras castillanas . .	25·353	0·4061	11·500
Majorca, Minorca ,, = 26 ,, ...	22·928	0·3673	10·400
Gibraltar ,, = 25 ,, ...	25·435	0·4075	11·537
Buenos Ayres, Chili, Mexico, Peru, Uruguay, La Havana, Manila, the Castilian arroba .	25·353	0·4061	11·500
Portugal :—			
The Portuguese arroba (weight-unit) is the quarter of the quintal.			
Lisbon, arroba = 32 arrateis	32·381	0·5187	14·688
Brazil and Goa, the Lisbon arroba.			

The kachcha man.	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
SOUTHERN AND CENTRAL INDIA :—	Cwt.	Fwt.	Kilog.
The kachcha man = 40 kachcha ser (see Sers) in some cases 8 vis.			
The exceptions were the following :—			
CENTRAL INDIA :—			
Bhilsa, man = 48 ser	0·8204	1·4720	41·679
Indor, kachcha man = 20 ser	0·3619	0·6493	18·385
Mandissor, man = 15 ser	0·2970	0·5329	15·090
Omatwara, man = 28 ser	0·4880	0·8756	24·793
Pertabghur, man = 20 ,,	0·3431	0·6179	17·496
Rutlam, Malwah, and Banswara, man = 20 ser	0·3616	0·6488	18·371
Ujjen, man = 16⅞ ser	0·2979	0·5345	15·134
SOUTHERN INDIA :—			
Baroda,[1] man = 42 ser	0·3983	0·7145	20·232
Belgaum, man = 44 ser	0·2344	0·4205	11·906
Ballari, man = 48 ser	0·2266	0·4066	11·512
Bombay,[1] man, for arrack = 50 ser	0·6850	1·2289	34·797
Calicut, man = 34 pounds = 60 ser	0·6210	0·5571	15·775
Cannanor, man = 30 pounds = 60 ser	0·2740	0·4916	13·919
Carwar, man = 42 ser	0·2301	0·4059	11·692
Cochin, man = 30 pounds	0·2911	0·4352	12·324
Colachi, man = 30 rotal	0·2015	0·3615	10·235
Darwar, man, for liquids = 48 ser	0·2204	0·3955	11·198
Goa, man = 24 rotal = 24¾ pounds avoir.	0·2210	0·3965	11·227
Jamkhair,[1] man (dry) = 64 ser	1·3182	2·3651	66·968
Pallamkatta, man = 2 tulam = 200 pullam	0·2232	0·4005	11·340
Puna,[1] besides a man of 40 ser, there are five.			
Surat,[1] besides a man of 40 ser there are several.			
Telichery, man = 32 pounds = 64 ser	0·2922	0·5244	14·847
Tranquebar, man = 68 Danish pounds	0·6685	1·1991	33·963
Travankor, man = 25 olundas for metals and sugar	0·2443	0·4383	12·409
Travankor, also a man = 30 olundas (general)	0·2931	0·5259	14·891
,, man = 25 putur or rotal	0·2235	0·4009	11·352
Trichinopalli, man = $8\frac{1}{3}$ vis = 25 pounds av.	0·2232	0·4005	11·340

In several places a special man for cotton of 42 ser (local) was commonly used; and occasionally also a man of 40 ser ([1]) in addition to the man given in the table.

THE FOOT-WEIGHT OR TALENT (fwt.).

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
ENGLAND :—	Lbs. av.	Fwt.	Kilog.
The commercial foot-weight, or talent, being the weight of an English cubic foot of distilled water at 62° Fahr. in air, by standard constructed and legalised in 1859 for Great Britain	62·3210	0·9983	28·2686
The scientific foot-weight at 32° Fahr. (the water at 39° Fahr. in vacuo; in correspondence with the French standard method) = 1000 millesimal or English ounces = 1 million mils = 1 billion doits, on the English scientific system, = 28·315 311 931 kilogrammes	62·4245	1·	28·3153
FRANCE :—			
The kilogramme, theoretically the weight of a cubic décimètre at 0° Cent. of water in vacuo at 4° Cent. = 2·204 621 25 pounds, av.; since 1864 = 35·316 580 740 millesimal ounces English. Its old value was 2·204 857 14 lbs. av.	2·2046	0·0353	1

VARIOUS NOMINAL ENGLISH UNITS.

	Lbs. av.		Lbs. av.
Truss of straw	36	Barrel of gunpowder	100
,, new hay	60	,, stockfish	100
,, old ,, (Sept. 1)	56	,, raisins	112
Tod of wool	28	,, candles	120
Barrel of anchovies	30	,, flour	196
Pocket of wool	120	,, butter = 4 firkins	224
,, malt	140	,, soap = 4 ,,	256
Seam of glass	120	Faggot of steel	120

HUNDREDWEIGHTS AND ANALOGOUS UNITS.

GENERAL VALUES.		English Commercial Equivalent. Cwt.	English Scientific Equivalent. Fwt.	French Scientific Equivalent. Quintals
The English hundredweight .	= 112 pounds	1	1·7942	0·5080
The ,, cental . . } The American hundredweight }	= 100 ,,	0·8929	1·6019	0·4536
The Zollverein metric centner	= 100 ,,	0·9842	1·7658	0·5000
The Prussian centner . .	= 110 ,,	1·0127	1·8170	0·5145
The Danish and Norwegian centner	= 100 ,,	0·9830	1·7637	0·4994
The Swedish centner . .	= 120 ,,	1·0004	1·7950	0·5082
The Austrian ,, . .	= 100 ,,	1·0756	1·9779	0·5606
For Russian centners see Local Values, p. 230. See also imperial berkowitz, under Loads, p. 234.				
The French metric quintal .	= 100 kilog. }			
The Italian centinajo = 10 rubbi	= 100 ,, }	1·9684	3·5317	1
The Nederlandsche centenaar	= 100 ,, }			
Switzerland: the Waadt quintal	= 100 pounds	0·9842	1·7658	0·5000
Spain : the Castilian quintal .	= 100 ,,	0·9055	1·6246	0·4600
Portugal : the Lisbon ,, .	= 128 ,,	1·1565	2·0749	0·5875
Ottoman Empire : the Stambul cantar . . .	= 100 rotl	1·1112	1·9935	0·5645
Egypt : the Cairo cantar .	= 100 ,,	0·8481	1·5217	0·4309
Algiers : kantar attari .	= 100 ,,	1·0749	1·9286	0·5461
Persia : the man i hasham	= 16 man i bushahr	1·1146	1·9997	0·5662
India : the man or maund .	= 40 ser	0·7347	1·3182	0·3732
China : the picul . .	= 100 tching	1·1832	2·1229	0·6011
,, the export picul	= 100 English catti	1·1905	2·1359	0·6048
,, the Dutch ,,	= 100 Dutch ,,	1·2093	2·1729	0·6153
Japan : the tan or picul .	= 100 king	1·1607	2·0825	0·5897

LOCAL, FORMER, AND SPECIAL VALUES.

GERMANY :—

The Zollverein metric centner	= 100 pounds	0·9842	1·7658	0·5000
Altenburg centner . .	= 110 ,,	1·0104	1·8128	0·5133
Baden ,, = 10 stein .	= 100 ,,	0·9842	1·7658	0·50

HUNDREDWEIGHTS, &c. —*continued.*		English Commercial Equivalent. Cwt.	English Scientific Equivalent. Fwt.	French Scientific Equivalent. Quintals
GERMANY—*continued* :—				
Bavarian centner = 5 stein .	= 100 pounds	1·1023	1·9777	0·56
Rhenish-Bavaria, centner .	= 100 kilog.	1·9684	3·5317	1
Bremen, centner . . .	= 116 pounds	1·1377	2·0412	0·57797
Brunswick, centner . .	= 114 ,,	1·0486	1·8814	0·53272
Cassel ,, . .	= 108 ,,	1·0294	1·8470	0·52298
Coburg ,, . .	= 110 ,,	1·1039	1·9794	0·56078
Cöln, old ,, . .	= 106 ,,	0·9754	1·7501	0·49555
Darmstadt ,, . .	= 100 ,,	0·9842	1·7658	0·5000
Frankfurt on Main, centner .	= 100 ,,	0·9947	1·7846	0·50530
Hamburg & Holstein, centner	= 112 ,,	1·0679	1·9160	0·54253
Hanover, centner . .	= 112 ,,	1·0794	1·9366	0·54835
Lippe-Detmold, centner .	= 108 ,,	0·9936	1·7828	0·50479
Lübeck, centner . . .	= 112 ,,	1·0684	1·9168	0·54275
Nuremberg, old centner .	= 100 ,,	1·0039	1·8012	0·51000
Oldenburg, centner . .	= 100 ,,	0·9535	1·7107	0·48440
Prussian ,, = 5 stein .	= 110 ,,	1·0127	1·8170	0·51448
Rostock ,, . .	= 112 ,,	1·0679	1·9160	0·54253
Saxony ,, = 5 stein .	= 110 ,,	1·0123	1·8162	0·51425
Wiesbaden ,, . .	= 106 ,,	0·9821	1·7621	0·49894
Würtemberg ,, . .	= 100 ,,	0·9206	1·6518	0·46771
,, augmen. centner	= 104 ,,	0·9575	1·7179	0·48642
SWITZERLAND :—				
Waadt, centner . . .	= 100 pounds	0·9842	1·7658	0·5000
Arau, centner . . .	= 100 ,,	0·9381	1·6832	0·47660
Basel ,, . . .	= 100 ,,	0·9708	1·7418	0·4932
Berne ,, . . .	= 100 ,,	1·0238	1·8368	0·5201
Saint Gall, centner .	= 100 light ,,	0·9153	1·6422	0·4650
Geneva ,, (liq.)	= 104 heavy ,,	1·1273	2·0227	0·5727
Grisons, heavy centner	= 100 ,, ,,	1·0242	1·8375	0·5203
,, light ,,	= 100 light ,,	0·9104	1·6334	0·4625
Solothurn centner . .	= 100 ,,	1·0202	1·8305	0·5183
FRANCE :—				
The metric quintal . .	= 100 kilog.	1·9684	3·5317	1
Old quintal poids de marc .	= 100 pounds	0·9635	1·7288	0·4895
NETHERLANDS :—				
The metric centenaar . .	= 100 kilog.	1·9684	3·5317	1
Old Amsterdam centenaar .	= 100 pounds	0·9726	1·7451	0·49409
,, Brussels ,,	= 100 shop ,,	0·9206	1·7220	0·4677
AUSTRO-HUNGARIAN EMPIRE :—				
Zollverein centner . .	= 100 pounds	0·9842	1·7658	0·5000
Vienna ,, . .	= 100 ,,	1·0756	1·9779	0·56006
Old Bohemian centner = 6 stein	= 120 ,,	1·2152	2·1803	0·61734

HUNDREDWEIGHTS, &c. —*continued.*		English Commercial Equivalent.	Scientific English Equivalent.	French Scientific Equivalent.
		Cwt.	Fwt.	Quintals
AUSTRO-HUNGARIAN EMPIRE —*continued* :—				
Galician-Lemberg centner = 75 Vienna pounds . .	= 100 pounds	0·8067	1·4836	0·42005
Tyrol, Botzen heavy centner	= 100 ,,	0·9862	1·7693	0·5010
,, ,, light ,, .	= 100 ,,	0·6509	1·1678	0·33065
Cracow, centner = 4 stein .	= 128 ,,	1·0227	1·8349	0·51955
,, also a centner .	= 100 ,,	0·7990	1·4335	0·40590
Trieste, the Vienna centner		1·0756	1·9779	0·56006
RUSSIA :—				
See berkowitz, among Loads, p. 234.				
Pernau, centner = 6 liespfund	= 120 ,,	0·9127	1·7656	0·4999
Revel ,, = 6 ,,	= 120 ,,	1·0181	1·8265	0·5172
Warsaw ,, = 4 heavy stein	= 128 ,,	1 0217	1·8331	0·5190
,, ,, = 4 light ,,	= 100 ,,	0·7982	1·4321	0·4055
ITALY :—				
Metric centinajo = 10 rubbi .	= 100 kilog.	1·9684	3·5317	1
Cagliari, cantarello . .	= 104 pounds	0·8325	1·4936	0·42291
Genoa, cantaro grosso . .	= 150 ,,	1·0295	1·8471	0·52300
,, ,, sottile . .	= 150 ,,	0·9360	1·6793	0·47550
Modena, centinajo . .	= 100 ,,	0·6697	1·2015	0·34020
Nice ,, = 6 rubbi .	= 150 ,,	0·9200	1·6507	0·46740
Naples, cantaro grosso .	= 100 rottoli	1·7539	3·1467	0·89100
,, ,, piccolo .	= 150 pounds	0·9471	1·6992	0·48114
Rome ,, = 10 decine .	= 100 ,,	0 6675	1·1976	0·33910
Sardinia, cantarello . .	= 100 ,,	0·8002	1·4356	0·40650
Sicily, cantaro ordinario .	= 250 ,,	1·5627	2·8037	0·79388
,, ,, grosso . .	= 275 ,,	1·7190	3·0841	0·87327
Tuscany, centinajo (since 1836)	= 100 ,,	0·6684	1·1992	0·33955
Venice, centinajo grosso .	= 100 ,,	0·5931	1·0641	0·30133
,, ,, sottile .	= 100 ,,	0·9270	1·6848	0·47705
SPAIN :—				
The Castilian quintal = 4 arrobas	= 100 pounds	0·9055	1·6246	0·4600
Aragon, quintal = 4 arrobas .	= 144 ,,	0 9921	1·7800	0·5040
Cataluña, quintal = 4 ,, .	= 104 ,,	0·8189	1·1779	0·4160
Bilbao, quintal pequeño o ordinario	= 100 ,,	0·9631	1·7280	0·4893
Bilbao, quintal macho, for iron	= 146 ,,	1·4062	2·5230	0·71438
,, ,, for fish . .	= 110 ,,	1·0595	1·9009	0·53823
Cadiz ,, ordinario = 4 arrobas	= 100 ,,	0·9055	1·6246	0·4600
Cadiz, quintal macho = 6 arrobas	= 150 ,,	1·3583	2·4369	0·6900

HUNDREDWEIGHTS, &c. —*continued.*		English Commercial Equivalent. Cwt.	English Scientific Equivalent. Fwt.	French Scientific Equivalent Quintals
SPAIN—*continued* :—				
Galicia, quintal = 4 arrobas	= 100 pounds	1·1342	2·0350	0·57620
Valencia ,, = 4 ,,	= 144 ,,	1·0072	1·8071	0·51168
Majorca and Minorca, cantaro ordinario = 4 arrobas	= 104 ,,	0·8189	1·1779	0·4160
Majorca and Minorca, cantaro barbaresco	= 100 ,,	0·7874	1·1326	0·4000
Canary Islands, South America, Antilles & Mexico, Manilla: the Castilian quintal.				
Brazil and Madeira: the Lisbon quintal		1·1565	2·0749	0·5875
GREECE, MEDITERRANEAN, ETC. :—				
Malta, cantaro = 100 rottoli	= 250 pounds	1·5580	2·7953	0·79150
Cyprus ,, = 100 ,,		4·6822	8·4007	2·37868
,, Famagusta cantaro = 104 rottoli		4·8695	8·7367	2·47383
Ionian Islands, Levantine cantaro = 44 oka	= 44 oka	1·0607	1·9031	0·53887
Anglo-Levantine talent (English cental)	= 100 pounds	0·8929	1·6019	0·45359
Former Levantine talent = 100 lbs. peso grosso		0·9370	1·6848	0·47705
Greece generally, cantaro	= 44 oka	1·3244	2·3761	0·67280
,, Patras ,,	= 132 pounds	1·0384	1·8630	0·52752
,, also, the Stambul kantar		1·1112	1·9935	0·5645
OTTOMAN EMPIRE :—				
The Stambul kantar = 44 oka	= 100 rotl	1·1112	1·9935	0·56450
,, kantar for cotton	= 45 oka	1·1364	2·0388	0·57733
Wallachia, the Stambul kantar	= 100 rotl	1·1112	1·9935	0·5645
Candia, kantar = 44 oka	= 100 ,,	1·0407	1·8672	0·52869
SYRIA :—				
Aleppo and Alexandretta, ordinary kanthar	= 100 rotl	4·4880	8·0522	2·2800
Aleppo and Alexandretta, kola = 7 vesnos	= 35 large rotl	1·5708	2·8183	0·7980
Aleppo and Alexandretta, zurlo	= 27½ ,,	1·2342	2·2144	0·6270
Damascus, kanthar	= 100 rotl	3·5307	6·3347	1·7937
Smyrna, kanthar = 45 oka	= 100 rotl	1·1381	2·0424	0·5782
,, also a kanthar of 44 oka.				
Tripoli, ordinary kanthar	= 100 small rotl	3·5762	6·4163	1·8168
,, large ,,	= 100 large ,,	4·2915	7·6996	2·1801
MESOPOTAMIA :—				
Bassara, man = 24 wakia		1·0356	1·8580	0·52610
,, man-attari = 24 wakia-attari		0·2499	0·4485	0·12698

HUNDREDWEIGHTS, &c. —*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
EGYPT :—	Cwt.	Fwt.	Quintals
Alexandria, kanthar = 36 oka nearly = 100 rotl	0·8634	1·5503	0·43897
Cairo, ordinary kanthar = 36 oka = 100 rotl	0·8392	1·5217	0·43087
The canthars of Cairo are about 10 to 12 in number varying from 36 to 82 okas in value.			
TUNIS AND MOROCCO :—			
Tunis, kanthar . . . = 100 rotl	0·9170	1·7788	0·50366
Tripoli ,, . . . = 100 ,,	0·9914	1·7574	0·49760
Mogador ,, . . . = 100 ,,	1·0594	1·9007	0·53818
Morocco generally, kanthar . = 100 ,,	0·9931	1·7819	0·50454
Bengazi, kanthar = 50 oka . = 125 ,,	1·2244	2·1967	0·62200
ALGIERS :—			
Kantar attari . . = 100 rotl-attari	1·0749	1·9286	0·54608
,, for cheese and cotton = 110 ,,	1·1824	2·1214	0·60069
,, gharduri, vegetables = 112½ ,,	1·2093	2·1696	0·61434
,, kebir . . = 150 ,,	1·6124	2·8929	0·81912
,, for butter and fruit oil = 166 ,,	1·7843	3·2014	0·90649
,, for hemp and flax = 200 ,,	2·1498	3·8571	1·09216
PERSIA :—			
Man i hasham = 16 man i bushahr . .	1·1146	1·9997	0·56623
INDIA :—			
The Imperial man, mun, or maund = 40 Imperial ser	0·7347	1·3182	0·37324
NORTHERN INDIA :—			
The old local man = 40 local ser (see Ser).			
EAST ASIATIC :—			
Anam, tan = 10 yen = 100 kan . . .	1·2277	2·2027	0·62369
Thaï (Siam), the hap or pikul = 50 chang .	1·1942	2·1426	0·60668
Malacca, pikul = 100 Malacca catti . .	1·2054	2·1626	0·61235
English ,, = 100 English ,, . .	1·1905	2·1359	0·60479
Sumatra, tampang = 60 ,, ,, . .	0·7143	1·2816	0·36287
Dutch pikul = 100 Dutch catti . . .	1·2111	2·1729	0·61525
Molucca, pikul = 100 Molucca catti . .	1·1627	2·0860	0·59067
Banda, soekel = 28 Banda catti . . .	1·5250	2·7361	0·77474
Manilla, pikul = 100 Manilla catti . .	1·2452	2·2341	0·63258
China, common pikul = 100 tching . .	1·1832	2·1229	0·60110
,, export pikul / ,, Anglo-Chinese } = 100 English catti .	1·1905	2·1359	0·60479
Japanese tan or pikul = 100 king . . .	1·1607	2·0825	0·58967

LOADS AND ANALOGOUS UNITS.

Load, karch, bürde, charge, carga, carica, schiffpfund, skippund, frachtpfund, pfundschwer, schwerpfund, berkowitz.	English Commercial Equivalent. Cwt.	English Scieutific Equivalent Fwt.	French Scientific Equivalent. Quintals
EUROPE :—			
The load is a general expression for 3 local quintals, centner, or cwt.; for values deduce from cwts., &c., p. 226–221. The following are mostly exceptional :—			
ENGLAND :—			
The load (generally) = 3 cwt. . . .	3	5·3825	1·5241
The pig of lead = 300 pounds . . .	2·6914	4·8058	1·3608
The sack of wool = $3\frac{1}{4}$ cwt.	3·25	5·8310	1·6511
The load of straw = 36 trusses = 1296 pounds .	11·5714	20·7611	5·8786
,, hay = 36 ,, = 2160 ,, .	19·2857	34·6018	9·7976
NORWAY AND DENMARK :—			
Skippund = 20 lispund = 320 pounds . .	3·1457	5·6439	1·5981
SWEDEN :—			
Skippund = 20 lispund = 400 skålpund . .	3·3348	5·9832	1·6942
There were also skippunds of 400 stapelstadswigt pund, 400 bergwerkwigt pund, and 400 landstadswigt pund.			
GERMANY :—			
German schiffpfunds.			
Prussian schiffpfund = 20 liespfund = 330 pounds	3·0381	5·4509	1·5434
Bremen ,, ,, = 290 ,,	2·8442	5·1030	1·4449
Brunswick ,, ,, = 280 ,,	2·5755	4·6210	1·3084
Hamburg ,, ,, = 280 ,,	2·6689	4·7901	1·3563
Hanover ,, ,, = 280 ,,	2·6985	4·8415	1·3709
Lübeck ,, ,, = 280 ,,	2·6709	4·7920	1·3569
Nüremberg ,, ,, = 300 ,,	3·0117	5·4034	1·5300
Oldenburg ,, ,, = 290 ,,	2·7651	4·8072	1·4048
Rostock ,, ,, = 280 ,,	2·6698	4·7901	1·3563
Bremen, pfundschwer or frachtpfund = 300 lbs.	2·9423	5·2789	1·4948
Hamburg and Rostock, pfundschwer or frachtpfund = 320 pounds	3·0512	5·4744	1·5501
Hanover, pfundschwer or frachtpfund = 336 pounds	3·2381	5·8098	1·6451
Lübeck, pfundschwer or frachtpfund = 320 lbs.	3·0512	5·4769	1·5508
Stettin, bürde of steel = 3 centner = 336 pounds	3·0987	5·5595	1·5742
Vienna, karch = 400 pounds of Vienna . .	4·4097	7·9118	2·2402

LOADS, &c.—*continued.*	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Cwt.	Fwt.	Quintals
FRANCE :—			
Old charge = 3 quintals = 300 lbs. p. de m. .	2·8906	5·1863	1·4685
Nice, old charge = 300 pounds	1·8401	3·3014	0·9348
Bruxelles, poose or charge of coal = 144 lbs. .	1·4847	2·4797	0·6735
Anvers old charge = 400 pounds . . .	3·6825	6·8881	1·8708
SPAIN, &C. :—			
Alicante, carga = 2½ quintales = 240 libras mayores	2·5180	4·5177	1·2792
Aragon, carga = 3 quintales = 432 libras . .	2·9762	5·3399	1·5120
Malaga ,, = 2 serones = 175 ,, cast. .	1·5846	2·8430	0·8050
Cataluña and Majorca, carga = 3 quintales = 312 libras	2·4566	4·4075	1·2480
Quayaquil, carga of cacao = libras cast. . .	0·7244	1·2997	0·3680
Valencia ,, = 3 quintales = 432 libras menores	3·0215	5·4211	1·5350
ITALY :—			
Venice, carica = 400 pounds peso sottile .	2·3723	4·2564	1·2052
RUSSIA :—			
Imperial berkowitz = 10 pud = 400 funt . .	3·2244	5·7851	1·6381
Pernau, schiffpfund = 20 liespfund = 400 pounds	3·2804	5·8855	1·6665
Revel ,, = 20 ,, = 400 ,,	3·3953	6·0918	1·7249
Riga ,, = 4 lof ,, = 400 ,,	3·2916	5·9056	1·6722
ARABIA :—			
Betelfaghi, bahar = 40 farzel . = 800 rotl .	7·2814	13·0640	3·69912
Jiddah ,, = 10 ,, . = 500 rattal .	1·6338	2·9313	0·83000
Mokha ,, = 15 ,, . = 300 ,, .	4·0179	7·2087	2·04117
PERSIA :—			
Kharwar = 100 man i tabriz	5·8060	10·4153	2·94912
CENTRAL INDIA AND GUZRAT :—			
The māni = 12 local man (see Man); in four exceptional cases it is otherwise, but there is then a maniāsa also (see Maniāsa), p. 237.			
SOUTHERN INDIA :—			
The kandi or bahar = 20 local man (see Man).			
The following are special values.			
Anglo-Madras, kandi = 20 kachcha man = 160 vis	4·4643	8·0097	2·26796
Anglo-Bombay, kandi = 20 kachcha man = 800 ser	5	8·9708	2·54012

LOADS, &c.—*continued.*	English Commercial Equivalent. Cwt.	English Scientific Equivalent. Fwt.	French Scientific Equivalent. Quintals
CEYLON AND BURMA :—			
Anglo-Cingalese kandi = 500 pounds avoir. .	4·4643	8·0097	2·26796
Old Dutch kandi = 480 pounds Troy Dutch .	4·6684	8·3765	2·37163
Burma, English kandi = 500 pounds avoir. .	4·4643	8·0097	2·26796
Old Pegu kandi = 150 local vis . . .	4·5440	8·1528	2·30849
EAST ASIATIC :—			
Malacca, bahar = 3 Malacca pikul = 405 lbs.	3·6162	6·4878	1·83705
English ,, = 3 English ,, = 400 ,,	3·5715	6·4077	1·81437
Tocopa ,, = 80 vis = 476 ,,	4·25	7·6252	2·15910
Queda ,, = 15 hali = 240 ganta = 480 ,,	4·2857	7·6893	2·17725
Jansalon ,, = 80 vis = $485\frac{1}{3}$,,	4·3333	7·7747	2·20144
Sumatra ,, = 560 pounds avoir. = 560 ,,	5	8·9708	2·54012
Acheen ,, = 200 Acheen catti . . .	3·7805	6·7829	1·92060
Banda ,, = 100 Banda ,, = 610 lbs.	5·4464	9·7718	2·76692
Batavia, amat = 2 Dutch pikul . . .	2·4222	4·3457	1·23051
Java, bahar = 3 ,, . . .	3·6333	6·5186	1·84576
Batavia, tampang = 5 Dutch pikul . .	6·0555	10·8643	3·07627
Molucca, bahar = 3 Molucca ,, . . .	3·4880	6·2581	1·77201
China, large export bahar = $4\frac{1}{2}$ English pikul	5·3573	9·6116	2·72156
,, small ,, = 3 ,,	3·5715	6·4077	1·81437
Anam quan = 5 tan or pikul. . . .	6·1384	11·0133	3·1185

TONS AND LASTS OF HEAVY GOODS.

GENERAL AND SPECIAL FORMER LOCAL UNITS.	English Commercial Equivalent. Tons	English Scientific Equivalent. Fwt.	French Scientific Equivalent. Milliers
England: ton = 20 hundredweight . .	1	35·883	1·0160
A ton of 40 foot-weight on the scientific series	1·1147	40	1·1326
America: ton = 2000 pounds = 20 centals .	0·8929	32·039	0·9072
DENMARK:—			
Danish last (heavy goods) = 5200 pounds .	2·5559	91·713	2·5969
Elsinor ,, ,, = 12 skippund .	1·8874	67·726	1·9177
SWEDEN:—			
Last of heavy goods = 5760 pounds (skålpund)	2·4011	86·158	2·4396
GERMANY:—			
Prussian ton = 2000 pounds	0·9206	33·036	0·9354
Hamburg, ton = 2000 pounds . . .	0·9535	34·215	0·9688
Frankfurt ,, = 2000 ,, . . .	0·9946	35·691	1·0106
Prussian last (heavy goods) = 4000 pounds .	1·8413	66·072	1·8708
,, ,, also a last = 12 schiffpfund .	1·8229	65·411	1·8521
Bremen ,, of heavy goods = 4000 pounds .	1·9615	70·386	1·9930
Frankfurt, last = 2 tons = 4000 pounds . .	1·9892	71·382	2·0212
Hamburg, schiffslast = 2 tons . . .	1·9070	68·429	1·9376
,, commerzlast = $2\frac{1}{2}$ tons . . .	2·3837	85·537	2·4220
Hanover, last = 3360 pounds = 30 centner .	1·6191	58·098	1·6451
NETHERLANDS:—			
Last of heavy goods = 2000 kilog. . . .	1·9684	70·633	2
Old Amsterdam last = 4000 ponden . .	1·9451	69·804	1·9764
FRANCE:—			
Tonne, tonneau, or millier = 1000 kilog. .	0·9842	35·317	1
Old French tonne = 2000 lbs. poids de marc .	0·9635	34·575	0·9790
RUSSIA:—			
Ton = 60 pud = 2400 pounds . . .	0·9673	34·711	0·9828
Last of heavy goods = 120 pud = 2 tons . .	1·9346	69·421	1·9657
Perma = 8 packen = 4 tons	3·8693	138·842	3·9314
SPAIN:—			
Spanish tonelada = 2000 pounds .	0·9055	32·491	0·9200
Alicante ,, = 1920 pounds = 80 arrobas.	1·0091	36·209	1·0253
Mexican timber tonelada = 2240 pounds cast. .	1·0141	36·390	1·0304
S. American cajon (mineral) = 50 quintales .	2·2637	81·228	2·3000
Malaga, last = 6200 pounds cast. net . .	2·8070	100·723	2·8520
,, large last = 8800 pounds cast. gross .	3·9841	142·961	4·0480

TONS AND LASTS, &c. —*continued.*	English Commercial Equivalent. Tons	English Scientific Equivalent. Fwt.	French Scientific Equivalent. Milliers
PORTUGAL :—			
Portuguese tonelada and Rio de Janeiro ton } 1728 pounds	0·7806	28·011	0·7932
Pernambuco ton = 2240 pounds	1·0119	36·311	1·0282
ITALY :—			
French tonne (see Millier).			
Formerly the old Amsterdam last	1·9451	69·804	1·9764
,, the English ton	1	35·883	1·0160
Livorno, last = 5600 pounds Tuscan	1·8714	67·154	1·9015
PERSIA :—			
Ḳara = 100 man i hasham	5·5729	199·97	5·6623
NORTHERN INDIA :—			
Sau man = 100 man (Imperial)	3·6735	131·82	3·7324
Also values based on the local man now obsolete. (See Man and Ser.)			
CENTRAL INDIA :—			
Maniāsa = 100 mānī invariably.			
Special Values.			
Bhairsiah, 100 mānī = 400 man	13·7754	494·31	13·9964
Bhilsa ,, = 375 ,,	15·3825	551·99	15·6298
Bhopal ,, = 4000 passari	22·3853	803·26	22·7445
Omatwara ,, = 800 man	19·5214	700·49	19·8347
SOUTHERN INDIA :—			
Garsah = 20 kandi = 400 man (generally).			
Values.			
Bangalur, garsah = 30 kandagon	4·5283	162·49	4·6009
Madras ,, = 20 kandi	4·3061	154·52	4·3752
Pondicherri ,, = 7200 pounds poids de marc	3·4688	124·47	3·5244
CEYLON :—			
Colombo, garsah = 9256½ pounds avoir.	4·1324	148·28	4·1987

MISCELLANEOUS LASTS AND ANALOGOUS UNITS.

	English Commercial Equivalent. Tons	English Scientific Equivalent. Fwt.	French Scientific Equivalent. Milliers
ENGLAND :—			
Wool-lasts = 39 cwt.	1·95	69·972	1·9813
Last of flax, hemp, or feathers = 17 cwt.	0·85	30·501	0·8636
Last of gunpowder = 2400 pounds	1·0714	38·447	1·0886
Fodder of lead, London and Hull = 19½ cwt.	0·95	34·089	0·9652
,, ,, Newcastle = 21½ ,,	1·075	38·575	1·0923
,, ,, Derby = 22½ ,,	1·125	40·369	1·1431
NORWAY AND DENMARK :—			
Last of butter (net) = 2688 pounds	1·3212	47·409	1·3424
,, ,, according to Norwegian standard	1·3158	47·215	1·3369
SWEDEN :—			
Last of hemp and flax, tallow, and malt = 6 skippund = 2400 skalpund	1·0005	35·899	1·0165
RUSSIA :—			
Last of hemp and flax, hair, isinglass, tobacco, and Russian thread = 60 pud	0·9673	34·711	0·9828
Last of candles, foreign thread, and of wax in barrels = 80 pud = 8 berkowitz	1·2897	46·281	1·3105
Last of resin, soap, or wax in bales = 100 pud	1·6122	57·851	1·6381
Last of caviar, tallow, linseed oil, potash, copper and iron; also of heavy goods = 120 pud = 12 berkowitz = 2 tons	1·9346	69·421	1·9657
For Lasts of Capacity see Measures of Capacity.			
ROD-WEIGHT.			
England: rod-weight of the decimal system = 1000 footweight or talents = 1 million ounces = 1 billion mils = 1 trillion doits = 25 tons of the same series	27·868	1000·	28·315

MODERN METROLOGY

PART II.—METRICAL SYSTEMS.

CHAPTER I.

SYSTEMS AND MODES OF SUBDIVISION.

WHILE many of the primitive units of measure mentioned in the foregoing chapters were originally perhaps independent, and afterwards became either primary or secondary units, and were re-arranged both in value and in proportion to each other, yet some of them became nearly obsolete, and others came forward into common use ; several becoming less suitable to direct measurement from changes in commercial usage and in the commercial products principally dealt with, and some also becoming inconvenient in calculation from not being aliquot parts, or multiples or sub-multiples of other more useful primary measures.

The first result of such changes was the systematisation of a series of measures of length and distance, a series for surface, a series for capacity, and a series for weight. Sometimes also there remained two or three sets in each series ; these sets being often independent of each other.

The next result was the formation of a complete

system of measures of length, surface, capacity, and weight, arranged with perfect interdependence, and sometimes also following one single method of subdivision throughout the whole.

The connection between the series of measures of length, surface, capacity, and weight, which alone justified the name of *system*, was made in various ways.

The relation between measures of length and of surface was apparently a most easy arrangement; the multiple of some unit of length in common use was squared to form a unit of surface, and from this unit of surface a set of multiples and submultiples, or secondary units of surface were formed. This, the most simple and ordinary method, was, however, inconvenient from its incompleteness; it was also necessary that the secondary units of surface should bear some convenient proportion to the secondary units of length, besides to that from which it was derived; otherwise calculation became troublesome. We have at present an example of this defect in English measures; the acre is 43560 square feet, or 4840 square yards, or 160 old square poles, which are perfect multiples; the acre is also $\frac{1}{640}$ of a square mile, a perfect sub-multiple; but the representation of the acreside in feet, in yards, in poles, and in parts of a mile is by no means simple or rapidly calculated, for the reason that the acre was based on the square pole, irrespective of its relations with the foot, yard, and mile being convenient or otherwise.

The relation between measures of length and of capacity was a matter much neglected by many nations in ancient times, for the reason that measures of capacity were not much used at an early epoch, weight being the mode of estimating commercial produce, both liquid

and solid; hence generally the above-mentioned relation was adjusted only when perfect systematisation was deemed necessary.

The general relation, whenever made, was in accordance either with the cubit, with the foot, or with the half-foot, or some fraction of it, or some other linear unit; thus—

Egyptian Grand Artaba	was the	cube of the	Natural Cubit.
Egyptian Royal Artaba	„	„	Royal Foot ($\frac{2}{3}$ Royal Cubit).
Egyptian Common Artaba	„	„	Egyptian Foot ($\frac{2}{3}$ Natural Cubit).
The Ancient Hindu Chari	„	„	Hindu Cubit.
The Arab Den or Kor	„	„	Hashemic cubit.
Greek Metretes	„	„	Olympic Foot.
Roman Congius	„	„	half a Roman Foot.

Danish, Swedish, Prussian, and French capacity-measures are based on cubic units.

The relation between measures of capacity and measures of weight was diversely made, according as it was thought advisable to conform the former to the latter, or the latter to the former.

In some cases the measures of weight were based on ancient and arbitrary standards, and the rectification of the measures of capacity was effected by adjusting them to certain weights of some common liquid or agricultural produce. Thus in China, the ching of capacity was adjusted to the ching (or pound) weight of unhusked rice; in England the bushel was formerly adjusted to 56 lbs. of wheaten flour or of meal, and at one time to 60 lbs. of wheat; and in recent times only to 80 lbs. of distilled water. The Roman amphora or

quadrantal was at one time adjusted to 80 Roman pounds' weight of wine.

The preferable method, however, adjusted the measures of weight to those of capacity, and thus rendered systematisation more simple ; for example—

One of the Egyptian Talents was the weight of a Common Artaba of Water (cubic foot).

The Great Attic Talent (Solon) was the weight of a Metretes of water (cubic foot).

The Arab Artaba weight was the weight of an Arab Artaba of water.

The Arab Yusdruman was the weight of $\frac{1}{720}$ of this.

The Lesser Greek Talent was the weight of an Amphora of water.

One of the Roman Amphoræ was the weight of a Roman cubic foot of water.

The Kilogramme is the weight of a litre of water (nominally).

When the whole of these relations became, or were, perfected, the result was a complete system of measures of all sorts, suitable for calculation as well as for weighing and measuring, such as those of Ancient Egypt, Ancient China, probably those of Assyria, those of Ancient Greece, and probably at one period those of Ancient Rome.

In modern ages in Europe, we have not only debased units, but also disjointed systems to deal with ; the debased units, being approximations to the original correct units, are almost invariably excellent for purposes of weighing and measuring, and for all the objects of detached trades and commercial matters they have met the requirements of ages, and want little more than rectifying ; the disjointed systems, however little they may

affect detached trades, are, on the contrary, a considerable difficulty to the calculator, to the scientific man, and to all trades and professions that habitually deal with more than one, or with several sets of measures.

The principle of facilitating calculation has been thoroughly carried out in the design of the metric system, in which the relations of the measures of length, surface, capacity, and weight have been carefully adjusted ; this advantage has, however, its counterpart in the comparative disadvantages it possesses as regards purposes of weighing and measuring in commercial affairs, and as regards the practical inconvenience of many of its units of measurement, and the fact that many others remain mere decimal names, instead of practically useful measures. The choice of the demi-toise or mètre, as the basis of this system is one much to be lamented ; had a natural unit been used instead, and had a practical man developed the system, it might have been as good in weighing and measuring as it is convenient in calculation. At present the mètre fails as a geodetic unit, and many of its dependent units fail in commercial convenience.

Decimal subdivision.—The most primitive and ancient method of estimating and dividing measures is doubtless the decimal system. From information given in the appendices to the Ninth Annual Report of the Warden of the Standards, 1874-75, it appears that the Ancient Egyptian standard-weight and copper coinage were based on this system, and the following was the scale :—

1 Ten or Men = 10 Kat	=	1400 grs. English.
1 Kat	=	140 grs. English.

The Ten or Men thus being about one-fifth of a

pound, deduced from the weight of a 5-Kat weight found at Thebes, being 700 grains. A papyrus of the period of Rameses II. gives an account in Ten and Kat, and the inscriptions at Karnac both mention Ten and Kat, and state amounts of tributes in Ten up to 3000. It is also extremely probable, from the units of measure being few, and from the remarkable apparent similarity of habit that the Ancient Egyptians had to the Chinese, that a system of decimal subdivision of any unit was as common with the former nation as with the latter. The land-measure of Egypt was, according to Herodotus, an aroura = 10000 sacred square cubits; or 100 cubits square.

The ancient measures of China, which are said to date from the reign of Hoang Ti, or about 2600 years B.C., were generally decimal. Doursther thus gives the ancient measures of capacity to be :—

1 kou = 10 teu = 100 chin = 1000 ho = 10000 yo,

and estimates 1 kou = $2\frac{1}{5}$ English bushels.

There seemed also to have been some corresponding system of measures of weight, the lowest unit being the weight of a grain of millet; 100 millet grains = 1 tchu, and ascending by a decimal scale up to the tān; but there is also an opinion that there was always a break in this system, and that the Chinese pound or tching was always = 16 liang, or ounces; although it is more probable that several systems existed. The Tān, according to Doursther, was $50\frac{4}{5}$lbs. English.

The decimal subdivision of any unit is so imbedded in the minds of the Chinese that any other but a decimal fraction requires special explanation; the terms of

decimal subdivision were probably in ancient times much as now, any unit being =

10 fan = 100 li = 1000 hao = 10000 ssa = 100000 hoe, &c.,

continued down to the trillionth part.

The advantages of rapidity of calculation accompanying any decimal system are very great, and the rigidity of the ancient decimal systems of Egypt and China has been scrupulously imitated by the French in their metric system. It can be applied to any unit equally well, provided that there is an indifference as to whether the dependent units of the system are convenient or inconvenient for commercial purposes in weighing and measuring. It must, however, be noticed that the convenience is solely due to accordance with numerical notation, as regards decimality.

Sexagesimal subdivision.—This method prevailed with the Chaldæans, Babylonians, Assyrians, and Phœnicians, also with the Egyptians, under certain dynasties in the period intervening between that of the early decimal system before mentioned, and that of the later Ptolemaic or Phileterian decimal system. Cycles of time were invariably reckoned as periods of 60 years; the Indians still date back in cycles from the Kali-Yog; the Chinese also; this method was universal; the century of 100 years is a comparatively modern arrangement.

The subdivision of both time and angular measurement into minutes and seconds is the remnant of it now surviving in Europe; in India the subdivision of the day into 60 ghaṛi (or periods equal to 24 minutes), the ghaṛi into 60 pul, and the pul into 60 taz, each equal to 0·4 second of European measure, still indicates the perfect sexagesimal method of those ancient astro-

nomers; latterly the English commuted the ghaṛi into a sub-multiple of the hour.

All the ancient talents of a certain epoch, whether monetary, commercial, or royal, or specially for gold, were in the same way divided into 60 pounds or manáh, and these manáh into sixtieths or shekel. The values of these are given in Chisholm, 'On the Science of Weighing and Measuring' (page 47). Among these it is most likely that the manáh was the original unit, based on 60 pieces of money, or small bars of gold or silver, the same mode being afterwards applied to the talent. A double system, in which one set of talents, manáh, and shekel were respectively equal to double those of the other, shows strong attachment to this subdivision. The larger measures of capacity, the cor or komer of Media, and the artaba of Egypt, were also divided into 60 hin, according to some accounts.

The sexagesimal system possessed the advantage of facility of subdivision into thirds, sixths, and twelfths, as well as into tenths, but appears to demand some digital notation specially adapted to it in order to render it practically convenient in every respect.

Duodecimal subdivision.—The system of subdivision into twelfths, ounces or inches (unciæ) was carried out by the Romans; their foot was divided into 12 unciæ; their jugerum, a small acre of 28800 square feet, equal to about $2987\frac{1}{2}$ square yards English, was subdivided into 12 unciæ; their sextarius, a measure of capacity one sixth of the congius, was divided into 12 unciæ; and the libra, or pondo, or pound, was divided into 12 unciæ. Each of the four standard units was termed an *as* or entire original unit; its duodecimal fractions from $\frac{11}{12}$ down to the $\frac{1}{12}$ were denominated deunx, dextans,

dodrans, bes, septunx, semis, or sexunx, quincunx, triens, quadrans or teruncium, sextans, uncia. The term sescunx for an uncia and a half, corresponding to the anderthalb of the Germans and the deṛh of the Hindus, afforded a convenient single term for expressing the eighth part of the as in unciæ, and for the ounce and a half without using a fractional term ; for this there also appears to have been at one time a single digital symbol also.

The multiples of the as, the tressis, quadrussis, quincussis, sexcussis, septussis, octussis, nonussis, decussis, or 10 as, were, on the contrary, on a decimal scale, in accordance with their notation, which was decimal in intention, although not dependent on place or position of the numerals. All European nations that took their foot measures through the Romans followed the duodecimal subdivision ; while in the subdivision of the pound, the Italians, the French, and the English alone adopted it partially for commercial purposes, although it was retained by almost all European nations for the division of the medicinal pound.

Excellent as the duodecimal system may be for purposes of subdivision of a single unit, it appears to fail when applied beyond that limit without the aid of some special corresponding notation or arrangements of digits.

Binary subdivision.—The reciprocals of numbers that admit of perpetual halving down to unity, such as, 2, 4, 8, 16, 32, and 64, form excellent sub-multiples of measures to serve as secondary units of a lower degree ; some of them also afford exact square roots and cubic roots in integers, and thus give simplicity of relation between the units of surface and of capacity, and the original measures of length. Besides these conditions, which

may be termed partly theoretical, and principally affect calculation, there is the higher advantage that measures subdivided on a binary scale possess considerable convenience in actual weighing and measuring (*which is the main object of commercial measures*), as a half of any weight or measure throughout the series can always be conveniently arrived at, an advantage conceded neither by decimal subdivision, nor strictly even by duodecimal subdivision, but only arrived at by the device of treating the term $1\frac{1}{2}$, an improper fraction, as a special digit.

For instance, the halves of 3, 5, 7, and 9 on a decimal scale run into inconvenient fractions; the square roots of 10, 1000, and 100 000 are inconvenient, so also the cube roots of 100, 10 000, and 1 000 000; while the numbers on the decimal scale that do not give surds are very few and very far apart. A binary subdivision hence is a more civilised arrangement for commercial measures, and seems to have been adopted both by the commercial and by the more intellectual nations; the Romans for commercial purposes, the Hindus, the Germanic, and Teutonic races; while decimalisation was favoured by primitive nations only for commercial purposes, though even now well adapted to the scientific purposes and calculations of advanced races.

The Hindus were perhaps among the earliest of nations to adopt binary subdivision; their system of expressing fractions is clear of decimal terms, being real fractional terms, and not mere reciprocals in form of language. Thus their natural subdivision is—

The ādha $=\frac{1}{2}$; the pāo $=\frac{1}{4}$; the adhpāo $=\frac{1}{8}$; the chittak and the anna $=\frac{1}{16}$; the ādh-chittak $=\frac{1}{32}$; the pāwīn, or subsidiary quarter $=\frac{1}{64}$.

Originally this method applied to everything, though latterly it was retained only with reference to certain special units; thus the term chittak is now used for the $\frac{1}{16}$ of the ser (or common unit of weight); but it was also applied to the $\frac{1}{16}$ of the kottah (a unit of surface = 80 square yards) as well as other units. The anna, now mostly confined as a term to the $\frac{1}{16}$ of a tola, or rupī-weight for monetary weight, was also a term used in some parts of the country for the $\frac{1}{16}$ of a ser, thus corresponding to the chittak; the anna—or, more properly, āna—was also the $\frac{1}{16}$ of a large measure of capacity, the rāsh, principally used for salt on the Bombay coast, and equal to 1160 English bushels, or $14\frac{1}{2}$ loads. The gaz or yard was subdivided thus: 1 gaz = 2 hāth = 16 girah = 64 pāwīn; although there was also a subdivision of the girah into 3 unglī (fingers) or 9 jau (barleycorns); but it is remarkable that not only does this correspond to 1 yard = 2 cubits = 16 nails of English and Dutch subdivision, but the values are also identical with English units, if we reject exceptional local gaz.

The more ancient Hindu division of the day into 8 pahar or watches was distinct from the Chaldæan system of sixtieths borrowed at a later date.

The old Hindu measure of capacity, the chari, or cubic cubit, was divided in a corresponding manner:—

1 chari = 16 drona = 64 adhaca,
1 adhaca = 4 prastha = 16 kadaba,

but it seems doubtful whether measures of capacity were ever much used by them at any time. At present, measures of weight take their place entirely and almost exclusively in commerce.

The Arabs, although renowned for the decimal notation adopted by all civilised nations, also used binary subdivision.

The artaba measure was $= \frac{1}{4}$ den or kor, and $= 2$ kafiz $= 4$ khul $= 8$ woeba $= 16$ makuk.

The Arab batman of weight was thus divided; 1 great batman $= 4$ small batman $= 8$ oka $= 16$ rotl $= 32$ cheki.

The commercial European pounds are almost invariably divided into sixteenths (called ounces); not only so, but the Teutonic marks, or marcs, or half-pounds, are also invariably divided into sixteenths (called loths[1] or lodes) or half-ounces. The origin of these commercial pounds seems obscure, and the existence of the marc as an independent original unit appears also doubtful. Whether these pounds were based on the ancient Phœnician commercial pound, or whether the greater Attic mina, which corresponded to 16 Roman ounces derived by twelfths from the lesser mina, was the real origin, or both combined, is an interesting subject of antiquarian research; but the fact remains that the Teutonic races divide weight-units into sixteenths, although the standards have varied.

The same races divide their measures of capacity in the same way; not only in England does the quarter $=$ 8 bushels, and 1 bushel $= 4$ pecks $= 8$ gallons $= 16$ pottles $= 32$ quarts $= 64$ pints, but the malter, scheffel, and boisseaux of Europe mostly follow the same invariable principle of subdivision.

[1] This measure, known as the loth, and used all over Germany, Austria, and Switzerland, also in Holland as the lood, in Sweden, Denmark, and Norway as the lod, and in Russia and Poland as the loth and lutow, seems to be absent in England only, where it would be termed lode.

Such a mode, thoroughly well-suited to commercial purposes, cannot be lightly rejected.

Septimal Subdivision.—This method is generally subsidiary or secondary. Even the week of seven days, undoubtedly ancient, was probably the quarter of some approximate month. The English stone of 14 pounds, the eighth of a hundredweight of 112 lbs., appears to have been adopted to suit the weight of certain measures of flour—a bushel of flour weighing 56 lbs., and a peck of flour weighing 14 lbs.—also to suit certain, now antiquated, peck-loaf arrangements. The firkin of butter weighing 56 lbs., the Winchester bushel of Chester salt weighing 56 lbs., and the sack of wool being 26 stone of 14 lbs. each, are three other practical commercial considerations that rendered septimal division of the half-stone into pounds a real convenience. The English hundredweight is not the only one that consists of 112 lbs.; those of Altona, Hamburg, Hanover, Holstein, Rostock, and Stettin, are similarly subdivided.

The subdivision of the present pound into 7 000 grains seems to have been merely the result of accident, in the adaptation of former measures to each other on the correct principles of natural systematic development; though in this case the results shown in retaining the Troy grain with the avoirdupois pound, and allowing both the ounce and the dram to involve fractions of grains, were particularly unfortunate.

The so-called septimal subdivision of weight hence appears to be due to a particularly unfortunate series of causes now relatively unimportant. The subdivision into eighths or octaves is the real mode of dividing the hundredweight, each eighth consisting of 14 pounds;

the pound is also successively divided into sixteenths among all civilised nations ; the English 7-pound weight and 7000 grain subdivision are inconvenient. Were it not for the involved change, it would be best to divide the pound either into 8000 grains or into 6400 grains ; and besides, to abolish the hundredweight of 112 lbs., thus ridding the English system of the anomaly and encumbrance of septimality.[1]

Combined Modes of Subdivision.—When any collection of measures, as in England, presents a combination of all the foregoing modes of subdivision, it certainly appears complicated. The first wish of the calculator and of the scientific and professional man is then to render it convenient for calculation by modification. The last wish of the commercial man and tradesman is that the measures he uses should be altered in any way, for the reason that he does not calculate beyond narrow limits, but does wish to retain the measures to which he is accustomed, for purposes of weighing and measuring. In other words, each department of trade may have its requirements met by some portion of the rather heterogeneous collection, while rarely does any tradesman calculate throughout the entire series, or want to do so ; he does not reckon from the cubic yard and go on through the pint or the gallon to the hundredweight or ton ; and, besides, is quite indifferent regarding those who really have to do so, for he considers they should have a system of their own without interfering with his. Certainly, a series of commercial measures well suited to their object should not be broken up for

[1] The notion of sanctity attached to the number seven is an ancient Jewish relic that was condemned with sabbatarianism more than eighteen centuries ago.

professional or scientific purposes; the modes of subdivision suit the tradesman, and should not be radically altered. The various anomalies—such as stones of different sorts, tons of various description, also lasts and sacks, and the various quarters, quarts, and quarterns—are mostly matters of denomination, that may be adjusted by alteration of names. The rejection of some secondary units, and alterations of value not exceeding 5 per cent., could meet but little opposition. But any radical alteration of a useful system could only be the suggestion of one indifferent to the commercial convenience of the millions that use English measures.

In the Dominion of Canada, where the inheritance of old and heterogeneous measures was an incubus rather than a convenience, English measures have in the main been adhered to. The Act of 1873, legislating for the period of 1880, retains the English foot-measure, and from the standards made for Canada, its decimal multiples and sub-multiples appear in vogue there; it also adopts the cubit foot as a measure of capacity for gas, and all the English measures of capacity from the bushel to the half-gill; it adopts the English pound, the old English Troy ounce, and the English grain, and the decimal multiples and sub-multiples of all these three measures of weight. The old French measures of the province of Quebec are now limited to the Parisian foot, perch, square perch, and arpent. As regards the metric system, which has been permissive in Canada since April 1871, Mr. Brunel, the head of the Weights and Measures Department, states that 'he is not aware that it has been used by anyone in 'Canada, and that there does not appear much proba-'bility of this system being generally used there, though

'it has been adopted to some extent by scientific men 'for purposes of comparison' (see Warden's Report for 1874–75).

It may here be noticed that not only is Canada less fettered by the measures of the past than England, but that the province of Quebec with its old French associations may have supplied the scientific men that to some extent used the metric system.

If, then, the Canadians have already avoided a sentimental alteration of their commercial measures, it may be hoped that the English-speaking races will never fall into the blunder of applying French measures to their own commercial purposes. There are scientific men living out of France able to make a better system, and an English one, suited to English requirements.

Apart from the inconvenience attending the introduction of foreign measures, and the difficulties inherent in any attempt to incorporate them into any pre-existing system, it will be noticed, on examining the tables of systems, that there is considerable inconvenience attending combined modes of subdivision of any sort, when incorporated in a single system.

When a system is, like the early English, binary throughout, when 8 ounces = 1 marc, 2 marcs = 1 pound, 8 pounds of wine = 1 gallon, 8 gallons = 1 bushel, 8 bushels = 1 quarter, 4 quarters = 1 chaldron, the simplicity is convenient for trading purposes; when in the Chinese measures 1 tching-weight of rice = 1 tching of capacity, 10 tching = 1 ten, 10 ten = 1 tche, and, again, 1 tching = 10 fun, 1 fun = 10 li, 1 li = 10 hao, 1 hao = 10 ssa, 1 ssa = 10 hoe, &c., the simplicity is convenient for purposes of calculation. Whenever a ternary subdivision intervenes, as the English yard into three feet, the butt

into three barrels, homogeneity ceases; when an unaliquot term is introduced, as the pole of $5\frac{1}{2}$ yards, the chaldron of $4\frac{1}{2}$ quarters, incongruity results.

A combination of several systems, each the best in its own way, would not retain the advantages of any.

For instance, how needlessly complicated is the time-honoured subdivision of the medical or monetary pound, or of the marc:—20 grains = 1 obolus, 2 oboli = 1 scruple, 3 scruples = 1 dram, 8 drams = 1 ounce, and 8 ounces = 1 marc, or 12 ounces = 1 pound, as the case may be. The needlessness of an additional pound of 12 ounces in a system possessing a commercial pound of 16 ounces is now perfectly recognised; a marc of half-a-pound = 8 ounces answers every purpose without encumbering a system with duodecimals. Again, the scruple of one-third of a dram is of comparatively little practical use, and the introduction of ternary units in a binary series here shows to disadvantage; the English scruple has hence been nominally abolished. The old medical pound of Europe of 12 ounces, or 5760 grains, gives a marc of 8 ounces or 3840 grains, or a commercial pound of 16 ounces or 7680 grains; but if it is both practically and theoretically unnecessary to complicate the subdivision with the third of any of its sub-units to be expressed in a perfect number of grains, the whole arrangement of the subdivision immediately admits of simplification to an extent that was not possible before. The marc can then be made equal to 3 200 grains; the ounce or eighth will then be 400 grains, and the dram, its eighth will be 50 grains; or, by an alternative arrangement, it may be preferred to make the commercial pound 8 000 grains, the marc 4 000 grains, the ounce its eighth = 500 grains.

On the whole, then, it may be safely said that combined modes of subdivision are generally troublesome, though various combinations of the binary with the decimal system may be so devised as to be convenient, also that the simple binary, or the simple decimal mode of subdivision are severally in their own ways the best, the one being suited to commercial, the other to scientific and geodetic purposes.

This being generally well-accepted by those conversant with the subject, it becomes of interest to draw conclusions as regards the best practicable mode that could be adopted in England.

Already the distinction between scientific units at 32° and commercial units at 62° is fully recognised, both by officials and the general public. Hence the English scientific system should consist of purely decimal units at 32°, belonging to existing measures. This is carried out in the English scientific system described in a succeeding chapter and used throughout the tables. This system, extending over a wide range, can then form the skeleton or framework for intercalation in rearranging the commercial units on a binary or on a mixed decimal and binary mode whenever requisite. A proposal to this effect is made among the Proposed and Typical systems at the end of this book.

CHAPTER II.

THE COMMERCIAL SYSTEMS OF EUROPE.

An examination of the English system of commercial measures given at the end of this chapter, and a comparison between it and any other natural commercial system of measures in the world, will show it to be either as good or nearly as good as any other, excepting in one or two respects; while if the whole of the circumstances and conditions be taken into consideration, it may be considered the first, from being most suited to the circumstances and the people.

A country of large commercial transactions in every branch of trade is necessarily most liable to a superfluity of measures; and hence also to a considerable amount of incongruity; but when the extent and the diversity of English commerce is borne in mind it is a fact worthy of notice that the natural English system is a single system, having one foot, one mile, one acre, one pound, one gallon, and one bushel.

It will not, it is true, bear comparison with the French system as a scientific one, although it is infinitely superior to it for the commercial purposes of weighing and measuring in ordinary trade transactions; in fact, the pre-eminence it has is due to the fact that it

is not a scientific system, but purely adapted to convenience in commerce at an ordinary temperature.[1]

A purely artificial scientific system may be devised in a day, and with hardly any thought or care. The length of anyone's walking-stick may be taken as the basic unit of length, and a decimal system may be derived from it which will have a perfect uniformity and simplicity. As for the names, Greek and Latin affixes, or even German and French affixes, may be easily applied. But such a system would necessarily nearly ignore the exact wants of many branches of trade; and the haphazard plan of applying in trade the nearest applicable unit afforded by such a process is not a satisfactory one, as it amounts to a practical indifference to the requirements of commerce.

A commercial system of measures requires time for perfect development; it must be suited to the race, and their forms of thought and calculation; it must also prove its suitability to all trading purposes through a long practical employment; and finally, all improvement and systematisation, readjustments and rejections, should be gradual alterations, aiming at the perfect development of the original system, and at a convenient practical uniformity and simplicity, without violent departures, or borrowing extraneous measures from other nations.

Among the systems of Northern Europe, the Swedish,

[1] Professor Piazzi Smyth's remark on this subject is: 'Your conclusions and methods are strictly rational, but do not enter into the religious history of man,' &c.—February 20, 1877.

The following is the opinion of the late Warden of the Standards: 'There can be no question of the greater convenience of our Weights and Measures over those of the Metric System for the practical purposes of weighing and measuring; the units have been adopted as the most convenient, and our system is far better than the metric system; but for purposes of account it is inferior to it,' &c.—August 26, 1878.

the Danish, and the Prussian systems (see pages 289, &c.) seem to be complete and regular.

The Swedish system is excellent; its measures of capacity are arranged in strict accordance with cubic measure; but it is deficient as regards the measures of weight; the relation of weight to capacity is either doubtful or non-existent, while the large number of various pounds used for different purposes till very lately constituted a serious drawback.

The Danish system is also an excellent one; its basic unit, the foot, is based on the length of a simple pendulum beating seconds at sea-level *in vacuo* at a latitude of 45°; and thus possesses the peculiarity of not being dependent on the exactitude of preserved standards, although the reconstruction of a standard would involve rather intricate reduction of value. The Danish foot is also adopted in the Prussian system as the Rheinfuss; while the whole of the Danish system is used in Norway, although there may be some differences due to slight fluctuation of value in the standards. The Danish measures of capacity are arranged in accordance with cubic measure, although they have not the same regular binary arrangement that constitutes the beauty of the Swedish and of the English system. The Danish commercial pound is the weight of $\frac{1}{62}$ of a cubic foot of water at a normal temperature, and this scientific arrangement renders the system complete; it has, however, the defect that there is also a second pound for monetary and perhaps for a few other purposes.

The English system will compare favourably with both the Swedish and Danish systems as regards the regularity of its measures of capacity and their subdivision, though connection between weight and capacity

is inferior ; while, now that separate Troy weight and apothecaries' weight are both legally abolished, it has the advantage of having a single series of weight-units.

The Prussian system is in some respects superior to the Danish and Swedish systems, in others not so good. It has two sorts of foot-measures, one the Rheinfuss, the other a geometric foot, a tenth of the ruthe ; it has two pounds, one the commercial pound, another the medicinal pound of 12 ounces, a double method in vogue in Germany generally, from which English measures are free. The Prussian measures of capacity are in accordance with cubic-measure, being in aliquot ratios to them. The subdivision of the capacity-measures is well arranged in accordance with trade requirements from the quart to the fuder and the malter. The measures of weight are in accordance with the capacity-measures, the commercial pound being $\frac{1}{66}$ of a cubic foot of water *in vacuo* at the temperature of 15° Réaumur ; while the marc or half-pound retained is the ancient unit, the Cöln marc but slightly varied in value ; the other measures of weight follow the forms of multiple and sub-multiple well suited to German custom.

If, after scrutinising these three systems, the English system be examined, its advantages and defects become more clearly apparent. Its single system of linear measures is free from two sorts of foot, pole, or mile, or two sorts of inch—faults common to German systems ; its single system of measures of surface, one square pole, rood, and acre, is also an advantage, although it must be admitted that the acre is inconvenient from the acreside not being a round number. The remedy for this defect could be easily supplied by the adoption of the square furlong as a hide, which would be the

64th part of a square mile, while its side would be a furlong or 220 yards exactly: the hide would then be equal to 40 roods, or 10 acres, and the rood equal to 40 perches as before, without altering any measures at all; and the acre could be permissively retained until it became unnecessary and practically obsolete. A further improvement in the series of surface units might be effected by making the rood exactly 10000 instead of 10890 square feet. The present series, though single, is exceedingly bad as regards subdivision.

The series of English measures of capacity form a nearly complete binary system, equalled only by the Swedish; they are deficient, however, in one most important respect, that of not being in convenient accordance with cubic measure; for instance, the gallon is nominally 277·273844 cubic inches, and the whole system is correspondingly defective. The principle of basing the gallon on an arbitrary old French pound avoirdupois, that was never any part of the early English or Anglo-Saxon system, has been the cause of this difficulty. In the earlier period the gallon was eight pounds of wine, the pound being then an English pound. The incorporation of the French pound, after Cressy and Poitiers, into the English system thus disarranged the whole of the measures of capacity. The accordance of the latter with the measures of weight is, however, well defined.

There is also a defect in the upper part of the series; they do not correspond above the gallon for both wet and dry measures; the bushel is 8 gallons, the quarter 8 bushels, and the chaldron $4\frac{1}{2}$ quarters in dry measure; while in wet measure the firkin is 9 gallons, the kilderkin 18 gallons, and the barrel 36 gallons. Formerly and

for nearly a century and a half, the barrel of ale was 32 gallons, the kilderkin 16 and the firkin 8 gallons; the firkin and bushel being identical in capacity; the Elizabethan barrel of wine was also 32 gallons.

In the lower part of the scale the objection that a minim was not exactly a grain in weight has been met by introducing a series of liquid-grain measures into the system which will eventually perhaps supersede the old minim-measures entirely.

Proceeding to the English measures of weight, the utmost that can be said for them is that they form a single system, one pound, one quarter, one hundredweight, and one ton; there are not two sorts of liespfund and two sorts of schiffpfund, as in the German system, nor 5 or 6 liespfund and markpfund, as in the Swedish system. But beyond this advantage of simplicity and unity, there remains hardly a single advantage. The ounce is not exactly the $\frac{1}{1000}$ of a cubic foot of water, although very nearly so, and thus the adjustment of the whole series is imperfect. The Danish pound is $\frac{1}{62}$, and the Prussian pound $\frac{1}{66}$ of the respective local cubic foot of water, but until the English ounce is made exactly the $\frac{1}{1000}$ of a cubic foot of water, and the pound the $\frac{16}{1000}$, the connection is imperfect. The error in adjustment is less than $\frac{3}{10}$ per cent., and could be easily effected as soon as the misplaced veneration for the French avoirdupois pound has faded, without causing any serious disturbance in commercial transactions.

The subdivision of the English commercial pound is at present clumsy. It consists of 16 ounces, while the ounce is 16 drams, and the pound is also divided into 7000 grains, thus making the ounce $437\frac{1}{2}$ grains, and the dram 27·34375 grains. The cause of this very

inconvenient arrangement must be sought at its source; the avoirdupois pound originally consisted of 7680 grains, and thus the ounce was 480 grains, and the dram 30 grains; but as the old Troy pound consisted of 5760 Troy grains, and the avoirdupois pound was equivalent to 7000 of these Troy grains, the avoirdupois grain was abolished in the reorganisation of 1824, and the Troy grain alone retained; this unfortunate combination of Troy and avoirdupois measures has brought about the above result. It would have been better to have entirely abolished the Troy and the medicinal systems without retaining the Troy grain. A grain of either $\frac{1}{6400}$ or of $\frac{1}{8000}$ of the pound avoirdupois would give convenient values in grains to both the ounce and the dram.

It may be here mentioned that there is a widespread belief that there are still three stones existing in the English system, one of 14 lbs., one of 10 lbs., and one of 8 lbs.; the old meat stone of 8 lbs. is, however, declared an obsolete illegal measure in the Warden's Annual Report for 1876–7; while a stone of wool, or a stone of flour has always been 14 lbs.; the retention of obsolete measures in parts of the country cannot therefore be urged as a defect in the system itself.

If then the advantages of the English system balance its defects, or even nearly so, and allowance be made on the score of the immense commerce of England in comparison with that of Sweden, Denmark, and Prussia, and the consequent difficulty in effecting modification and improvement of measures, the English system may be fairly considered as good as any of them for purposes of trade.

While examining the systems of other countries a

marked line must be drawn between the natural systems peculiar to those countries and the artificial or metric and modified metric systems. The natural systems of the Hanse towns, Hamburg and Bremen, and those of Saxony, Brunswick, Gotha, Mecklenburg, and Oldenburg are inferior in systematisation to the Prussian system, although resembling it generally, and hence require no special comment.

The Austro-Hungarian system can hardly be said to present any preponderating advantages either as a system or from the values of its units, or the connection between them ; in this latter respect it appears rather unfortunate. Its advantages rather lie in the fact that it is or was a single imperial system adopted to a wide extent over many provinces, and that these centralised Austrian measures, perhaps inferior in themselves, were important from their wide acceptation. The Hungarian units given in Part I. are not European but Asiatic, and are parallel with Ottoman measures. The South German systems of Bavaria and of Würtemberg correspond slightly to the Austrian system, more especially the former. Of these three, the Würtemberg system is by far the most simple and well-arranged generally ; decimalisation is adopted, where applicable, among the inches, feet, and poles or ruthen, and binary subdivision is employed throughout the measures of capacity generally as most suited to them. The triple system of liquid measure, the hellaichmass (for clarified wine), the trübmass or mostmass (for unclarified wine or wort), and the schenkmass for retail sale, is the principal defect in these South German systems. In North Germany the double system of visirmass for gauging and schenkmass for retail sale is sufficiently troublesome, but on the whole the North-

German systems are much superior to those of Southern Germany.

The Russian system bears a strong similarity to the English; the Russian foot is identical with the English foot, thus making that unit the most widespread and largely-used linear measure of the whole world; and the whole of the Russian measures of capacity are based on weight, the vedro containing 30 lbs. of water, the tschetverka 64 lbs., and the whole of the rest in accordance with the English method. The Russians still, however, possess two pounds or funt, one the commercial, the other the German medicinal pound of Nuremberg. The dessätina of 2400 square sasheen is in accordance with English measure, the sasheen or fathom being exactly 7 English feet; and the werst, of 500 linear sasheen, is 3500 English feet. A peculiarity in the Russian series of weight-units deserves notice; both the stone and the hundredweight are absent, but there is a pud of 40 pounds, a berkowitz of 10 pud or 400 pounds, and a ton of 6 berkowitz. The pud is nearly half an English foot-weight or talent, about 36 pounds avoirdupois, and the berkowitz appears an approximate load of nearly 3 English hundredweight. The load (a camel load), perhaps the most widely used weight-unit, thus becomes important in the Russian system. The arrangement indicates that stones and hundredweights may be dispensed with in a commercial system. The accordance between English and Russian measures renders English and American tabular and scientific values of great value to the Russian, a convenience of which they avail themselves to the utmost.

A further increased similarity of the Russian and English measures may probably be made after the

English pound has been adjusted to cubic measure, as before explained; in that case the Russians would be wise to discard their two pounds, and adopt the single English pound as the basis of their systems of weight and capacity, thus completing the correspondence in every respect, and making one foot and one pound, of $\frac{16}{1000}$ths cubic foot of water, the most commonly used units in the world.

The French system, adopted for commercial purposes since 1840 in France, Holland, and Italy, and more recently adopted by other nations that are now in the unenviable state of transition from natural to artificial measures, may be said to be at present the most perfect system for scientific purposes and for purposes of calculation; these advantages would, however, be attained by any rigid decimal system.

For the ordinary purposes of commerce, and for all operations of weighing and measuring, it is of considerably less value. The units themselves, the mètre and the kilogramme, are particularly inconvenient and perfectly arbitrary; they coalesce with none of the natural measures of Europe, and are devoid of significance; the mètre is not, as was once supposed, a geodetic unit, and the kilogrammes of ordinary use are copies of the *kilogramme de l'Observatoire*, which is a doubtful copy of the *kilogramme des archives*, whose density cannot be determined by immersion from fear of injury. This latter kilogramme was the solitary standard originally made in 1799 by Fortin. The accepted description of the mode in which this cylinder was scraped to the size necessary to represent the weight of a décilitre of water, and its doubtful density, render its relation to a cubic decimètre of water rather doubtful from a scientific

point of view, while its copies twice removed are not likely to be better.

Apart from the excessive pretensions of the metric system, and the method of propagating it by complimentary expressions and devices, there cannot be found any advantage in it beyond that already mentioned, which would be inseparable from almost any complete and rigid decimal system.

The disadvantage in commercial dealings arising from the want of binary subdivision in the metric system is partly amended by using double measures and half measures of each unit in the decimal scale.

The transition period of measures in France, during which old measures were still actually, though perhaps not legally, in use, must have been nearly half a century—a considerable disadvantage. But drawbacks of this description were trivial to a nation that had an enormous number of old measures in inextricable confusion, probably more than a hundred values of units of land-measure, and so forth. The large variety of measures in former use in France, in Italy, and in the Netherlands rendered *any* new single system a boon ; the same may also be said of the Empire of Germany.

In the British Empire there is fortunately no such multiplicity of measures as to demand their abolition in favour of the introduction of the metric system, and if a decimal system were required, the decimalisation of some of the units in common use could be much more conveniently effected and applied in commerce. Besides, our experience in the past, from the adoption of the French avoirdupois and Troy pounds in preference to the old Anglo-Saxon merchant's pound, or any of the really English pounds, and the incubus they have been to our

system up to the present day, constitute a standing warning against adopting the newest French fashion in measures, apart from the difficulties of a transition period, which would be probably greater in England than they were in France.

On an examination of the metric measures that have become actual commercial units, apart from the nominal metric measures that are mere names, the first and most striking peculiarity that presents itself is the rarity of the cases in which the values approximate to any of the natural measures of the civilised world, and the utter impossibility of reducing metric values to natural values in any system, by means of simple multipliers and divisors. This last feature renders any attempt or proposition to incorporate metric measures in the natural measures of any country perfectly impracticable. This is perhaps extremely fortunate as saving much confusion that would otherwise accrue from the efforts of the mètre-propagators; in fact, as far as can be discovered, there has been only one such attempt yet made, the result being that the two sets of units remained purely distinct.

Taking the commercial metric units in detail, the mètre answers the purposes of the English yard, the Spanish and Portuguese vara, and the stab, or double ell of Germany, and corresponds to the half-fathom of some other nations; it is therefore a practically useful unit. The centimètre of about half an inch of most nations is a small and rather inconvenient unit; the decimètre is of little utility in measurement, and the millimètre is too small for most commercial purposes, its utility being confined to scientific employment and purposes of numerical expression. The kilomètre is a

small mile, which possesses no intrinsic advantage apart from its decimal advantages. These decimal advantages must be considered as perfectly separable matters, not as inherent in the metric system. The metric units of length are hence, with one exception, exceedingly inferior as commercial units, while the absence of any unit of length approaching in value to the foot of most civilised nations is a most serious defect. The nominal metric units of length—the decamètre, the hectomètre, and myriamètre, and the double decamètre or chain of 20 mètres, can hardly be considered as accepted commercial units of linear measurement.

Among the metric units of surface, which are excellently arranged with regard to each other, the square mètre is a practically useful unit; the hectare of about $2\frac{1}{2}$ English acres is nowhere near the surface-units of any civilised nation, with the solitary exception of Russian dessätina; and the square kilomètre does not approximate to any known square mile. The decimal interdependence of the metric surface-units is exceedingly convenient; a square kilomètre being 100 hectares, a hectare 100 ares, and an are 100 square mètres; but this would accompany any decimal system based on other non-metric units. There hence appears to be only one really useful and convenient commercial unit in this series, while the rest are hap-hazard decimal multiples.

In the metric measures of capacity, the litre is the basic unit; theoretically, this represents the volume of a cubic decimètre; but as, in fact, there is no such primary standard cubic decimètre of capacity, the litre is merely a measure containing a kilogramme weight of water, that cannot be practically tested, but merely verified by computation. This defect is due to the temperature of

4° Centigrade being taken as the standard for the water, and that of 0° for the vessel.

As a commercial unit, the litre is excellent; it is a very convenient and practical bottle-measure of wine or any liquid, and specially useful among nations with whom wine is an article of daily food and ordinary consumption. The décilitre and centilitre are mere decimal sub-multiples of the litre, and unimportant as units; the cubic centimètre or millilitre, equal to about 15 English liquid-grains or 17 minims, is the druggist's small unit of capacity. Whether such a quarter-dram is a practically convenient unit or not is very doubtful; apparently it is either too small or too large; all the assumed advantages in connection with it are really only those of decimalisation. The hectolitre of about 2¾ English bushels is nowhere near any corresponding grain-measure, scheffel, or fanega, of civilised nations. Among the metric measures of capacity, the litre-bottle is therefore the only commercial unit of practical convenience.

Continuing to measures of weight, the gramme is too large a unit for the more delicate commercial purposes for which other nations employ a grain; though in scientific matters its decimal sub-multiples down to the milligramme effect all the objects of persons quite indifferent about the values of the units they employ. The kilogramme is more than double the pound of any civilised nation in Europe, and hence an inconvenient unit as regards value, but it certainly is an approximation to the Turkish oka and the Indian seer, the former being about a fourth more, the latter about a tenth less. The quintal resembles the kilogramme in its relation to the units of other nations, the hundredweights, centners, and

quintals of Europe, and also is distant from the cantaros and maunds of Asia. The millier, bar, or tonne, sometimes also called a tonneau, is, however, a practically useful metric ton, and thus forms the solitary metric unit of weight that possesses real commercial convenience.

Summarising the results of the foregoing examination, the metric system affords the following convenient commercial units, the mètre and its square and cube, the litre and the metric ton; or one unit of length, one of surface, one of capacity, and one of weight, while the rest are unimportant decimal multiples and submultiples. Could any decimal system do less? Apparently not, unless devised with the declared object of ignoring all commercial convenience. It is, however, possible that any English schoolboy would decimalise better for English purposes on a walking-stick selected by him from a bundle. As a French scientific system, the metric system is excellent, for the single contact with natural commercial measures in each class is just sufficient for all such purposes; as a French commercial system it is an inferior one, adopted as a preferable alternative to the enormous collection of heterogeneous old French measures; for other nations falling into the same unfortunate predicament it is a *pis aller*, a mere mode of extrication; but for any country possessing a good single natural system of commercial measures, it is a snare and a delusion, that much resembles the soufflée, the fondant, the champagne-mousseux, the crinoline, and other inflated French inventions of puerile type.

As a universal commercial system it is deficient from the fact of its being decimal, for most commercial nations and races are essentially binary in habit and form of thought. The exclusive Chinese are decimal in

habit; for them it would be well suited, were it not that all this decimalisation has been borrowed from them, and that they subdivide to trillionths already with habitual ease; hence it might be more in accordance with the fitness of things for the French to have applied Chinese and Japanese prefixes to their metric terms. The Romans thought in duodecimals, the Greeks principally in sexagesimals, and the English, who afforded the French instructors in Latin in the time of Charlemagne,[1] have, like the rest of the Indo-Germanic races, always thought naturally in eighths. The English system of measures, which is commercial in origin and development, would, with a small amount of modification, form by far the most suitable universal system for Europe and the world; and even in the event of decimalisation superseding binary subdivision, a decimalised English system of measures based on English units would answer the corresponding purpose.

The enormous increase of French manufactures and general trade since the Cobden-Saint-Simonist Treaty, has been frequently urged as a reason for preferring French to English measures as a universal system; and

[1] In the period following the utter decadence of everything that was Roman, the knowledge of Latin of the higher type was alone thoroughly preserved in Cumbria, whence, at the special request of Charlemagne, Alcuin sent instructors to him for purposes of education. The ecclesiastical Latin of Rome was certainly continuously retained through the Church formularies as regards pronunciation, but probably accompanied with very contracted notions of meaning, and but little linguistic knowledge. The subsequent foundation of universities and colleges all over Europe, apparently with the sole object of reviving Latinity and theologic lore, supports this view.

In the Cymric ante-Roman period, Britain was the most highly civilised Western nation, to which young Gallic nobles were sent for education. France has never been pre-eminent in real civilisation, or deserving of imitation in matters of high importance.

hence this basis of argument cannot be neglected in its bearing on systems. It assumes that, as in the past the English, represented by the Cobden school of policy, have facilitated by treaty the loss of manufactures and commerce, and given English coal, iron, and manufacturing power in return for Lyons silk dresses and ornamental fabrics, in the future this doctrine will be perpetuated; that the English are bound hand-and-foot by a false form of free-trade, and cannot extricate themselves from this vicious circle. Certainly, if at intervals the English make commercial treaties of that sort, English trade is doomed to entire extinction; but the assumption of perpetual stupidity is too far-fetched, the English are progressive, they do profit from experience, and may yet retain the most important share of the commerce of the world, and sustain the ascendency of their own measures.

Besides the simple metric system as applied direct to commercial measures in France, Holland, Belgium, and Italy, for a long time past, there are several systems based on metric units, or modified metric systems, that either answer the purpose of a temporary or transitional system and lessen the abruptness of a change from natural to artificial measures, or afford a convenient relation to metric measures for countries and nations having a trade exclusively connected with that of others whose system is already metric.

The systems of this class are the French *mesures usuelles,* used from 1812 to 1840, as transitional; the Baden system, used from 1810 till lately; the Darmstadt system, adopted in the Grand Duchy of Hesse since 1818; and the Waadt system, exclusively used in the Canton Waadt since 1822, and partly in the Cantons Valais,

Schweitz, Uri, Zug, Zürich, Glaris, and Grisons, for some time, but afterwards applied to the whole of Switzerland. These four systems having been expressly devised to meet commercial convenience, are necessarily more suited both to purposes of ordinary trade, and to the people that use them, than the metric system itself; the latter being, on the other hand, preferable for scientific purposes only. The values of the commercial units of these systems are multiples and sub-multiples of metric units, but have local names in accordance with the old local measures; such units are necessarily quite out of accordance with any natural measures as regards exactitude, but approximate to them for purposes of convenience. It is evident that these systems in coalescing with metric units are cut adrift from all natural measures, and aim at adaptation to metric measures in combination with a superior adaptability to commercial purposes; in these objects they certainly succeed. On examining these four systems together, it will be noticed that the relation of the commercial foot to the mètre is diversely fixed, thus:—

	France.	Baden.	Hesse.	Switzerland.
Foot	$\frac{1}{3}$ mètre	$\frac{3}{10}$ mètre	$\frac{1}{4}$ mètre	$\frac{3}{10}$ mètre

also the French *pied usuel* is divided into 12 inches, and in the other three cases the foot is divided into 10 parts or tithes. These arrangements have important effect on the development in the square and cubic measures. Of these methods the Hessian is certainly preferable.

In surface-measures, the principal unit in each case holds some connection with the metric hectare, and with the smaller units of its own system, thus:—

	France.	Baden.	Hesse.	Switzerland.
Surface unit, pose or morgen	1 hectare 100 square perches	0·36 hectare 400 square ruthen	0·25 hectare 400 square ruthen	0·45 hectare 500 square ruthen

In small units of capacity the distinctive unit is thus connected with the litre, and with the smaller cubic units of its own system :—

	France.	Baden.	Hesse.	Switzerland
Mass, or small unit	1 litre $\frac{1}{8000}$ cub. toise	1·5 litre $55\frac{5}{9}$ cub. in.	2 litres 128 cub. in.	1·35 litre 500 cub. in.

The pound adopted is a half-kilogramme in every case.

The modes of subdivision adopted for the measures of capacity as well as throughout the four systems generally, are thus :—

	France.	Baden.	Hesse.	Switzerland.
Mode of subdivision	Mixed	Purely decimal	Binary	Nearly decimal.

Taking the connections of the measures with the cubic measures of the respective systems, that of Switzerland is the most convenient, that of Hesse correspondingly good for a binary system, while that of Baden, though regular, is clumsy, and that of France is convenient but rather irregular.

The comparison of these four systems of the same class of arbitrary artificial measures, adopted with untrammelled choice under very much the same conditions, affords a most useful and instructive example to those that advocate modified metric measures for England, America, or any other country, possessing a large trade with France, and wishing to satisfy both the internal and the export requirements of trade-convenience by a single intermediate system. Of the above four attempts, the Hessian system seems the preferable one in almost every respect; but whether any of these

methods is worthy of imitation is very doubtful ; probably the English method of using the purely metric system itself as a legally permissive system, whenever it may happen to suit the circumstances of a case, is a better alternative.

Returning to the subject of the natural measures and systems of measures of the past century, after this digression on the subject of artificial or metric units and measures, it may be here noticed that it has not been considered worth while to introduce in this book the old French measures existing before 1799, nor the old measures of the Netherlands. They were voluminous and complicated to a fearful degree, and now that they have not only been legally abolished, but also been allowed to fall into practical oblivion, for a very long time, they are seldom referred to. Even in local books, when these measures are referred to, their values in new measures generally accompany them. The old French measures that were principally in use at Paris have not entirely yet vanished from France ; persons still talk of and sell *onces* of tobacco, and *acres*, *arpents*, &c. of land in France itself ; in the French Antilles and some of the French possessions they are still referred to ; while in the Canadian province of Quebec the *perche* and the *arpent de Paris* were legally abolished only last year. Doubtless, there are many persons ready to inform one that all old French measures were abolished by law in the month Germinal of the year III. of the French Republic ; in spite of this, stern facts remain, and require explanation.

The collection of old Parisian measures is therefore given among the tables of systems ; but as a rule the older measures of various countries, that have existed

or been in use within the present century, and survive in language, books, and records, rather than in actual use, will be found not among the tables of systems but among the tables of measures in Part I., under the heads of Former Local or Special Values.

The old Italian measures, the German measures that have been for a long time abolished, and the old Swiss measures, will be thus found. As regards the German measures that have been abolished by law in the last few years and are merely surviving through a transitional period, these are necessarily treated in this book as recent measures still existing, because reference to them is frequently made and their values in English and in French terms are often wanted.

The Spanish and the Portuguese measures are supposed to have been abolished even as long ago as the Italian measures, and to have similarly made way for French metric measures. Though the old Italian measures have, with the exception of various local land-measures, been completely abolished as regards reference and expression, as well as by law, the Spanish measures have not yet vanished to the same degree.

The Spanish system is on the whole a good one; it much resembles the English in its advantages and defects, though certainly less simple and hence inferior; it requires a comparatively small amount of modification and adjustment to render it an excellent system, and far superior for commercial purposes to the metric system partially adopted in preference to it. The linear measures, up to the furlong of an eighth of a mile, and the mile of 5000 feet, are good and more simple than the corresponding English measures. The square measures include some rather complicated land-units; and if

the celemin, fanegada, and yugada were replaced by a square furlong and a square mile (in the same way as is much wanted in England), this class of measures would also become perfect.

The Spanish measures of capacity are, like the English, independent of local cubic measure; the dry-measures are simple and convenient units, but the liquid-measures, from having two arrobas and four butts of various sorts, inclusive of pipes, are extremely inconvenient. Were the term arroba abolished from the capacity-measures, and the whole of the liquid capacity-measures readjusted in strict accordance with the dry-measures, as well as with the cubic units, the whole would form a useful commercial system. The origin of the Spanish capacity-units is probably the makuk, and other Moorish and Arab units; while the Spanish cubic units are Gothic; hence the divergence of the two series.

The Spanish measures of weight are simple, excellently arranged, and admit of little improvement; there is but one pound of commerce, and the marc or half-pound is merely differently subdivided for monetary and medical purposes; the arroba of 25 pounds, the quintal of 100 pounds, and the tonelada of 2000 pounds, complete this very well-arranged class of measures.

The Portuguese system is greatly inferior to the Spanish system; the linear measures are complicated by an inconvenient cubit, and an irregular mile; the single land-measure, the geira of 4840 square varas, is, however, advantageous, and so also are the liquid-measures which are simple; the two alqueiras, one liquid, the other dry and of another value, are, however, troublesome. The Portuguese measures of weight resemble the Spanish

in all respects, excepting that the multiples adopted are less convenient.

The measures of Greece and Turkey in Europe will be given in the collection of Oriental measures in the following chapter, as they belong to a type distinct from the generality of European measures.

It may be here noticed that systems of the European type are markedly distinct from Oriental and Asiatic measures, apart from causes referable to mere geographical position and location of the races using them.

It is perhaps quite possible to assign an Asiatic origin or derivation for every measure in the world at present in existence; but in some cases this derivation is very remote, in others comparatively so, and in a few cases hardly admits of being clearly traced. European measures under their own distinctive type have become changed in a way peculiar to themselves, and differ in system and in arrangement from the Oriental systems from which they may have been derived.

The Moslem sway carried Oriental measures over North Africa, parts of Southern Europe, and the whole of Western Asia. The retention of those measures in the countries from which the Moors and Moslems were expelled was not of long duration, while the measures of the same type are retained in Moslem countries to the present day. The Christian form of religion is hence generally associated with distinctive type of measures, nearly peculiar to Europe at one period, but subsequently carried into America, where few indigenous measures are known to have existed. The peculiarities principally consist in the adoption of a foot as a basic standard unit of length, in preference to a cubit or ell, in using a pound as a standard unit of weight in preference to an

oka or larger unit, and in employing a systematised series of true measures of capacity in preference to measures of weight for liquid and dry merchandise. The adoption of these three principles seems to be distinctive of a race free from Moslem sway, and generally but not always peculiar to a Christian and European race. Any single one of these three principles may be ultra-European; thus the Arab rottal and vakia correspond exactly to European pounds and ounces, but the Arab foot is, when retained, not the primary unit of length, but gives way to the cubit; in China there is both a foot and a pound, but in China and Eastern Asia generally the capacity-measures are merely nominal, often hardly known to the masses, and replaced entirely by measures of weight in trade transactions. In Southern India, and the Burmese peninsula, beyond the limits of Moslem preponderance, true measures of capacity may be found, but then in most cases either the foot or the pound is missing. Such races have a geographical location at present widely distinct from that of the European races, and markedly separated from them, by the intervening extent of continent long retained under Moslem sway. The division of the measures of the world into three great classes, the European or Christian, the Oriental or Moslem, and the East-Asiatic or Pagan, is hence comparatively well-defined. As to indigenous African measures little is known, the North African measures being Oriental, and the South and East African measures being clearly assignable to an East-Asiatic origin. The indigenous American measures, like the aboriginal American races, have become matters of archaic curiosity.

The collection of the European systems of commercial measures here given is arranged in order as follows:—

1. Early English Measures. The Present English System. Conversion Tables.

2. The Russian; the Danish and Norwegian; and the Swedish Systems.

3. North German Systems (ten in number).

4. South German Systems: Austria, Bavaria, and Würtemburg.

5. The Spanish and Portuguese Systems.

6. The Old Measures of Paris, Amsterdam, Brussels, Florence, and Venice.

7. Metric Systems. 1. Present French System of France, Italy, and the Netherlands, with Conversion Tables; 2. The Mesures usuelles; 3. The Baden System; 4. The Hessian System; 5. The Swiss System.

Early English and Anglo-Saxon measures.

Inch=3 barleycorns
Foot=12 inches
Yard or ell=3 feet=16 nails; (the Elizabethan ell=45 inches abolished)
Rod (decemped or perch)=10 feet
Pole=$5\frac{1}{2}$ yards; (also poles of 6, 7, and 8 yards, and of 25 feet)
Furlong=40 poles
London mile=1000 paces=5000 feet
Common mile=8 furlongs=5280 feet

Square pole=$30\frac{1}{4}$ square yards
Rood=40 square poles
Acre=4 roods
Hide=100 acres

London (Stricken) measures for wine, corn and all produce.

Pint or pound of wine=nearly 29 cubic inches
Gallon=8 pounds=231 cubic inches
Bushel=8 gallons=64 pounds=1848 cubic inches
Quarter=8 bushels=512 pounds=14784 cubic inches
Chaldron=4 quarters=118272 cubic inches

Reputed Winchester and other measures, sometimes heaped.

Old Winchester corn gallon stricken=268·8 cubic inches
„ bushel „ =2150·4 „
„ chaldron=36 Winchester bushels stricken
Elizabethan ale gallon=282 cubic inches
Revived ancient measures, Queen Annian wine gallon } (London measure)=231 cubic inches
„ coal bushel=33 wine quarts=2218·48 cubic inches
Modern Winchester gallon of William III. =$272\frac{1}{4}$ „
„ bushel=60 lbs. of wheat=2150·42 „
Imperial gallon of 1824=277·274 „

Weight-units.

Anglo-Saxon marc=8 ounces=160 pence=5120 grains
Moneyers' pound=$1\frac{1}{2}$ marc=12 oz.=20 sh.=240 pence=7680 grs.
Merchants' pound=15 oz.=25 shillings=9600 grains
Commercial pound=2 marcs=16 ounces=10240 grains
Foreigners' pound (Dutch weight)=16 foreign oz.=256 for. drms.
Troy pound=12 troy ounces=240 pennyweights=5760 troy grains, used for bread till 1709.
Avoirdupois pound=16 avoirdupois oz.=7680 avoirdupois grains;
„ „ latterly=16 oz.=256 drams=7000 grains

For Standard Temperatures

The Anglo-Saxon units were taken in air at some ordinary temp. now unknown; probably very much as the present com. units. The later English units were taken at temp. 30° bar. 30″.

Equivalents in present English Commercial Measures.	French Equivalents.	
. . . . still retained	25·39	millim.
. . . . . ”	304·71	”
. . . . . ”	0·9141	mètre.
retained in Canada &c.	3·0471	mètres.
. . . . still retained	5·0277	”
. . . . . ”	0·2011	kilom.
retained on Indian Canals	1·5235	”
. . . . still retained	1·6089	”
. . . . retained	25·2775	mèt. carr.
. . . . . ”	10·111	ares.
. . . . . ”	0·40444	hectare.
. . . abolished in 1701	40·444	hectares.

		Period of Retention.		
. . .	0·8331 pint	Generally retained till 1413, Henry V.	0·4730	litre.
. . .	0·8331 gallon		3·7841	litres.
. . .	0·8331 bushel		30·273	”
. . .	0·8331 quarter		2·422	hectol.
. . .	0·7405 chaldron		9·687	”
heaped to	272 cub. in.	Retained till 1701 William III.	4·401 to 4·453	lit.
heaped to	2218 cub. in.		35·21 to 36·32	lit.
. . .	42·717 cub. ft.	Retained till 1713.	13·0757	hectol.
. . .	1·0170 gallon	1589 till 1824.	4·6169	litres.
. . .	0·8331 gallon	1707 till 1824.	3·7841	litres.
heaped to	2815 cub. in.	1713 till 1824.	36·32 to 46·09	”
. . .	0·9818 gallon	1701 till 1824.	4·4573	litres.
heaped to	2218·19 cub. in.		35·21 to 36·32	lit.
. . .	1· gallon	retained	4·5417	litres.
. . .	3600 grains	Abolished, Edward III.	233·277	grammes.
. . .	5400 ”		349·915	”
. . .	6750 ”	Abolished, Edward III.	437·393	”
. . .	7200 ”		466·553	”
. . .	7600 ”		492·472	”
. . .	5760 ”	Ed. III., till 1878.	373·242	”
. . .	7000 ”	Introduced Ed. III., retained.	453·593	”

see Chapter VI.

Present English Commercial Measures at 62° Fahr.

Commercial Units			Dec. Scientific Equivalent	
Inch			0·83308	tithe
Nail	=	$2\frac{1}{4}$ inches	0·18745	foot
Hand	=	4 inches	0·33324	foot
Foot	=	12 inches	0·99971	foot
Yard	=	3 feet	2·99913	feet
Fathom	=	2 yards	5·99826	feet
Pole	=	$5\frac{1}{2}$ yards	1·64952	rod
Furlong	=	40 poles	6·59809	chains
Mile	=	8 furlongs	0·52785	league
Square inch			0·69405	sq. tithe
Square foot	=	144 square inches	0·99943	sq. foot
Square yard	=	9 „ feet	8·99487	sq. feet
Square pole	=	$30\frac{1}{4}$ „ yards	2·72095	sq. rods
Rood	=	40 sq. poles	1·08838	sq. chain
Acre	=	4 roods	4·35352	sq. chains
Sq. furlong	=	10 acres	43·53517	sq. chains
Sq. mile	=	64 square furlongs	0·27863	sq. league
Cubic inch			0·578205	fl. ounce
Cubic foot	=	1728 cubic inches	0·999139	cub. foot
Cubic yard	=	27 „ feet	26·976753	cub. feet
Minim	=	0·0036 cubic inch	2·088621	fluid mils
Liquid grain	=	0·0040 cubic inch	2·291515	fluid mils
Fluid drachm	=	60 minims	125·3172325	fluid mils
Fluid ounce	=	8 fl. drms. = 1·7329 c. in.	1·002538	fl. ounce
Gill	=	5 fluid ounces	5·012690	fl. ounces
Pint	=	4 gills	20·050760	fl. ounces
Bottle	=	$1\frac{1}{3}$ pint	26·734347	fl. ounces
Quart	=	2 pints	40·10152	fl. ounces

[1] For the decimal units see Scientific Systems in a

N.B. The exact correspondence between capacity

with their Decimal Scientific Equivalents at 32°.[1]

Commercial Units		Dec. Scientific Equivalent
Quart .	=69·318 cubic inches .	40·101 515 fl. ounces
Pottle .	=2 quarts . .	80·203 03 fl. ounces
Gallon .	=2 pottles . . .	160·406 06 fl. ounces
Peck . .	=2 gallons . . .	320·812 12 fl. ounces
Bushel .	=4 pecks=1·2837 cub. ft.	1·283 248 cub. foot
Strike. .	=2 bushels . . .	2·566 497 cub. feet
Coom .	=2 strikes . . .	5·132 994 cub. feet
Quarter .	=2 cooms=10·2696 c. ft. .	10·265 9878 c. feet
Chaldron .	=4½ quarters . . .	46·196 9451 c. feet
Gallon .	=277·274 cubic inches .	160·406 06 fl. ounces
Firkin .	=9 gallons=1·4441 c. ft. .	1·443 654 54 c. foot
Kilderkin .	=2 firkins . . .	2·887 309 cub. feet
Barrel .	=2 kilderkins=5·7766 c. ft.	5·774 618 cub. feet
Hogshead .	=1½ barrel=8·6649 c. ft. .	8·661 927 cub. feet
Butt . .	=2 hogsheads . . .	17·323 854 cub. feet
Tun . .	=2 butts=34·6596 c. ft. .	34·647 709 cub. feet
Inch-weight	= { 252·458 grs. . . / 0·57705 oz. . . }	0·577 7445 ounce
Foot-weight	= 62·321 pounds . .	0·998 3425 foot-wt.
Yard-weight	= 15·0238 cwt. . .	26·955 2475 foot-wt.
Grain . .	. . . . . .	2·288 478 mils
Com. drachm	= 27·34375 grs. . .	62·575 55 mils
Med. drachm	= 54·6875 grs. . .	125·151 1 mils
60-grain drachm	. . . . .	137·308 666 mils
Ounce .	=437½ grains . . .	1·001 209 ounce
Pound .	= 16 ounces . . .	16·019 344 ounces
Stone. .	= 14 pounds . . .	224·270 76 ounces
Quarter .	= 2 stone . . .	448·541 52 ounces
Cental .	=100 pounds . . .	1·601 934 foot-wt.
Hundredweight	=112 pounds . . .	1·794 1661 foot-wt.
Ton . .	= 20 cwt. . . .	35·883 216 foot-wt.

succeeding chapter (Chapter VI., Part II.).
and weight does not exist in Commercial Units at 62°.

The English Commercial System at normal temp., 62° *Fahr.*,

Inch . . .			0·253 9229	décim.
Foot . .	=	12 inches . .	0·304 7075	mètre
Yard . .	=	3 feet . . .	0·914 1225	,,
Fathom .	=	2 yards . .	1·828 2450	,,
Rod . .	=	10 feet . . .	3·047 075	mètres
Pole . .	=	$5\frac{1}{2}$ yards . .	5·027 6738	,,
Chain (Gunter's)	=	4 poles . .	20·110 695	,,
Chain (Ramsden's)	=	100 feet . .	30·470 750	,,
Furlong .	=	40 poles . .	201·106 950	,,
Mile . .	=	8 furlongs . .	1·608 8556	kilom.
Square inch . .			0·064 4768	déc. carr.
Square foot .	=	144 square inches .	0·092 8467	mèt. carr.
Square yard .	=	9 square feet .	0·835 6199	,,
Square rod .	=	100 square feet .	9·284 6661	,,
Sq. pole . .	=	$30\frac{1}{4}$ square yards .	25·277 3350	,,
Sq. chain (Gunter's)	=	16 sq. poles .	4·044 4005	ares
Sq. chain (Ramsden's)	=	100 sq. rods .	9·284 6661	,,
Rood . .	=	40 sq. poles . .	10·111 0013	,,
Acre . .	=	4 roods . .	0·404 4401	hectare
Square furlong	=	10 acres . .	4·044 4005	hectares
Square mile .	=	64 square furlongs	2·588 4163	kil. carr.
Cubic inch . .			16·372 1492	cent. cub.
Cubic foot .	=	1728 cubic inches .	28·291 0738	déc. cub.
Cubic yard .	=	27 cubic feet .	0·763 8590	mèt. cub.
Minim . .	=	$\frac{1}{480}$ of a fluid ounce .	0·05914	millilitre
Liquid grain	=	$\frac{1}{70000}$ of a gallon .	0·06488	,,
Fluid drachm	=	60 minims . .	3·54823	millilitres
Fluid ounce .	=	8 fluid drachms .	28·38587	,,
Gill . .	=	5 fluid ounces	0·141 929	litre
Pint . .	=	4 gills . . .	0·567 717	,,
Bottle . .	=	$1\frac{1}{3}$ pint . .	0·756 956	,,

For connecting values of Measures of Capacity, Cubic
For English Scientific Values at 32° Fahrenheit,

with French Commercial Equivalents at 32° Fahr.

Quart .	. =	2 pints	. .	1·135 435 litre
Pottle .	. =	2 quarts	. .	2·270 869 litres
Gallon .	. =	2 pottles	. .	4·541 739 ,,
Peck .	. =	2 gallons	. .	9·083 477 ,,
Bushel	. =	4 pecks	. .	36·333 909 ,,
Strike .	. =	2 bushels	. .	72·667 818 ,,
Coom .	. =	2 strikes	. .	1·453 356 hectolitre
Quarter	. =	2 cooms	. .	2·906 713 hectolitres
Chaldron	. =	$4\frac{1}{2}$ quarters	. .	13·080 207 ,,
Last .	. =	10 quarters	. .	29·067 127 ,,
Gallon .	. .	. . .	. .	4·541 739 litres
Firkin .	. =	9 gallons	. .	40·875 647 ,,
Kilderkin	. =	2 firkins	. .	81·751 295 ,,
Barrel .	. =	2 kilderkins	.	1·635 026 hectolitre
Hogshead	. =	$1\frac{1}{2}$ barrel	. .	2·452 539 hectolitres
Butt .	. =	2 hogsheads	.	4·905 078 ,,
Tun .	. =	2 butts	. .	9·810 155 ,,
Inch-weight		. . . .	.	16·358 998 grammes
Foot-weight	=	1728 inch-weight	. .	28·268 349 kilogrammes
Yard-weight	=	27 foot-weight	. .	7·632 454 quintals
Grain .	. =	$\frac{1}{7000}$ of a pound	.	0·064 7989 gramme
Commercial drachm	=	27·344 grains	.	1·771 846 ,,
Medical drachm	=	54·69 grains	.	3·543 693 grammes
60-grain drachm	=	60 grains	. .	3·887 937 ,,
Ounce .	. =	16 com. drachms	.	28·349 54 ,,
Pound .	. =	16 ounces	. .	0·453 593 kilogramme
Stone .	. =	14 pounds	. .	6·350 297 kilogrammes
Quarter	. =	2 stone	. .	12·700 594 ,,
Cental .	. =	100 pounds	. .	0·453 593 quintal
Hundredweight	=	4 quarters	. .	0·508 024 ,,
Ton .	. =	20 hundredweight	.	1·016 048 millier

Measure and Weight, see pp. 119, 122, 141–143.
see tables in Chapter VI., Part II.

Conversion Tables for reducing English

Units.	Inches into décim.	Feet into mètres.	Yards into mètres.
1	0.253 923	0.304 708	0.914 123
2	0.507 846	0.609 415	1.828 245
3	0.761 769	0.914 123	2.742 368
4	1.015 692	1.218 830	3.656 490
5	1.269 615	1.523 538	4.570 613
6	1.523 537	1.828 245	5.484 735
7	1.777 460	2.132 953	6.398 858
8	2.031 383	2.437 660	7.312 980
9	2.285 306	2.742 369	8.227 103
10	2.539 229	3.047 075	9.141 225

	Sq. in. into décim. carr.	Sq. ft. into mètres carr.	Sq. yds. into mètres carr.
1	0.064 477	0.092 847	0.835 620
2	0.128 954	0.185 693	1.671 240
3	0.193 420	0.278 540	2.506 860
4	0.257 907	0.371 387	3.342 480
5	0.322 384	0.464 234	4.178 100
6	0.386 861	0.557 080	5.013 720
7	0.451 338	0.649 927	5.849 339
8	0.515 814	0.742 774	6.684 959
9	0.580 291	0.835 620	7.520 579
10	0.644 768	0.928 467	8.356 199

	Cub. in. into litres.	Cub. feet into litres.	Gallons into litres.
1	0.016 372	28.291 07	4.541 739
2	0.032 744	56.582 15	9.083 477
3	0.049 116	84.873 22	13.625 216
4	0.065 488	113.164 30	18.166 954
5	0.081 860	141.455 37	22.708 693
6	0.098 232	169.746 44	27.250 433
7	0.114 605	198.037 52	31.792 170
8	0.130 977	226.328 59	36.333 909
9	0.147 349	254.619 67	40.875 647
10	0.163 721	282.910 74	45.417 386

Commercial Measure into French Measure.

Units	Miles into kilom.	Grains into Grammes.	Ounces into kilog.
1	1·608 856	0·064 799	0·028 350
2	3·217 711	0·129 598	0·056 700
3	4·826 567	0·194 397	0·085 050
4	6·435 422	0·259 196	0·113 400
5	8·044 278	0·323 995	0·141 750
6	9·653 134	0·388 794	0·170 100
7	11·261 989	0·453 593	0·198 450
8	12·870 845	0·518 392	0·226 800
9	14·479 700	0·583 191	0·255 150
10	16·088 556	0·647 989	0·283 495

	Sq. miles into kilom. carr.	Acres into hectares.	Pounds into kilog.
1	2·588 416	0·404 440	0·453 593
2	5·176 832	0·808 880	0·907 186
3	7·765 248	1·213 320	1·360 778
4	10·353 664	1·617 760	1·814 371
5	12·942 080	2·022 200	2·267 964
6	15·530 496	2·426 640	2·721 556
7	18·118 912	2·831 080	3·175 149
8	20·707 328	3·235 520	3·628 742
9	23·295 747	3·639 960	4·082 334
10	25·884 163	4·044 401	4·535 927

	Bushels into hectolitres.	Cwts. into quintals.	Tons into milliers.
1	0·363 339	0·508 024	1·016 048
2	0·726 678	1·016 048	2·032 095
3	1·090 017	1·524 071	3·048 143
4	1·453 356	2·032 095	4·064 190
5	1·816 696	2·540 119	5·080 238
6	2·180 035	3·048 142	6·096 285
7	2·543 374	3·556 167	7·112 333
8	2·906 713	4·064 190	8·128 380
9	3·270 052	4·572 254	9·144 428
10	3·633 391	5·080 238	10·160 475

THE RUSSIAN SYSTEM.

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Vershoc	. . . .	1·8666 inch	0·15551 foot	47·396 millim.
Foot	. . . .	1 foot	0·99971 ,,	304·71 ,,
Arsheen	= 15 vershoc = $2\frac{1}{3}$ feet	$2\frac{1}{3}$ feet	2·33266 feet	710·99 ,,
Sasheen	= 3 arsheen = 7 feet	7 feet	6·99797 ,,	2·13297 mètres
Werst	= 500 sasheen	3500 feet	0·34990 league	1·06648 kilom.
Square foot	=	1 square foot	0·99943 sq. foot	9·28467 déc. carr.
Sq. sasheen	= 49 square feet	49 square feet	48·97207 sq. feet	4·54949 mèt. carr.
Dessätina	= 2400 sq. sasheen = 117600 sq. ft.	2·69972 acres	11·75320 sq. chains	1·09188 hectare
Cubic foot	. . . .	1 cubic foot	0·99914 cub. foot	28·29087 déc. cub.
Tsarka	= . . . = 0·3 lb. of water	0·21645 pint	4·33984 fl. ounces	0·1229 litre
Crushka	= 10 tsarki = 3·0 ,,	2·16453 pints	43·39836 ,,	1·2288 ,,
Shtof.	= . . . . 3·75 ,,	2·70566 ,,	54·24783 ,,	1·53605 ,,
Vedro	= 10 crushki = 30 ,,	2·70566 gallons	0·433984 cub. foot	12·2884 litres
Stekar	= $1\frac{1}{2}$ vedro = 45 ,,	4·05849 ,,	0·65097 ,,	18·433 ,,
Anker	= 3 vedro = 90 ,,	8·11698 ,,	1·30195 ,,	36·8652 ,,
Oxhoft	= 6 anker = 540 ,,	48·70188 ,,	7·81171 cub. feet	2·211912 hectol.
Botschka	= 40 vedro = 1200 ,,	108·2264 ,,	17·359345 ,,	4·9154 ,,
Garnetz	. . . . = 8 lbs. of water	0·72151 gallon	115·729 fl. ounces	3·2769 litres
Tschetverka	= 2 garnetz = 16 ,,	1·44302 ,,	231·458 ,,	6·5538 ,,
Tschetverik	= 4 tschetverka = 64 ,,	5·77208 gallons	0·92583 cub. foot	26·2152 ,,
Pajok	= 2 tschetverik = 128 ,,	1·44302 bushel	1·85166 ,,	52·4304 ,,
Tschetvert	= 4 pajok = 512 ,,	5·77208 bushels	7·40665 cub. feet	2·09722 hectol.
Last	= 16 tschetwert	11·54416 quarters	118·50637 ,,	33·55552 ,,
Dola	. . . .	0·68573 grain	1·56931 mil	0·04443 gramme
Sol	= 96 doli	65·83008 grains	0·15065 ounce	4·2657 grammes
Funt or lb.	= 96 solotnik	0·90283 pound	14·46274 ounces	0·40952 kilog.
Pud	= 40 funt	36·1132 pounds	0·57851 ft.-weight	16·38068 ,,
Berkowitz	= 10 pud	3·2244 cwt.	5·78510 ,,	1·63807 quintal
Ton	= 6 berkowitz	19·3464 ,,	34·71057 ,,	9·82841 quintals
Last	= 2 tons	1·93464 ton	69·42114 ,,	1·96568 millier
Medicinal funt	= $\frac{7}{8}$ commercial funt = 12 ounces (See Medicinal Measures, Chapter V.)	5529·765 grains	12·65474 ounces	0·358323 kilog.

THE DANISH SYSTEM, *also used in Norway.*

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Tomme	. . . .	1·030 003 inch	0·858 092 tithe	26·154 millim.
Fod	= { 12 tomme; $\frac{12}{38}$ of seconds pendulum at 45° N.L. }	1·030 003 foot	1·029 710 foot	313·85 ,,
Alen	= 2 fod	2·060 005 feet	2·059 420 feet	627·70 ,,
Favn	= 6 fod	2·060 005 yards	6·178 261 ,,	1·883 121 mètre
Rode	= 10 fod	10·300 030 feet	1·029 710 rod	3·128 535 mètres
Miil	= 4000 favn = 24000 fod	4·681 901 miles	2·471 304 rods	7·5325 kilom.
Square tomme	. . . .	1·060 931 sq. inch	0·736 34 sq. tithe	6·840 557 cent. car.
Square fod	= 144 square tomme	1·060 931 sq. foot	1·060 327 sq. foot	9·850 402 déc. car.
Square alen	= 4 square fod	4·243 722 sq. feet	4·241 306 sq. feet	39·401 608 ,,
Square favn	= 36 square fod	4·243 722 sq. yards	38·171 754 ,,	3·546 14 mèt. car.
Square rode	= 100 square fod	106·093 06 sq. feet	1·060 327 sq. rod	9·850 402 ,,
Toende sœdeland	= 1120 square rode	2·727 83 acres	11·875 659 sq. chns.	1·103 245 hectare
Toende hartkorn	= 2240 square rode	5·455 66 ,,	23·751 319 ,,	2·206 490 hectares
Square miil	= 16 million square favn	21·920 06 sq. miles	6·107 48 sq. leag.	56·738 314 klm. car.
Cubic tomme	. . . .	1·092 776 cub. inch	0·631 853 fluid oz.	17·891 106 cent. cub.
Cubic fod	= 1728 cubic tomme	1·092 776 cub. foot	1·091 841 cub. foot	30·915 831 déc. cub.
Holzfavn	= 72 cubic fod	2·914 067 cub. yds.	78·612 58 cub. feet	2·225 940 met. cub.
Cubic favn	= 216 cubic fod	8·742 200 ,,	235·837 74 ,,	6·677 819 ,,
Pot or krug	= 4 pœgel = $\frac{1}{32}$ cubic fod	1·7018 pint	34·1200 fluid oz.	0·9661 litre
Kanne	= 2 pott = $\frac{1}{16}$ cubic fod	1·7018 quart	68·2401 ,,	1·9322 ,,
Stübchen	= $8\frac{7}{8}$ pott = 0·121 09375 c. fod	3·2972 quarts	0·1322 cub. foot	3·7437 litres
Anker	= 10 stubchen = 1·210 9375 c. fd.	8·2429 gallons	1·3222 ,,	37·4371 ,,
Oeltoende	= 136 pott = $4\frac{1}{4}$ cubic fod	28·9300 ,,	4·6403 cub. feet	1·31392 hectol.
Ahme	= 4 anker = 4·84375 cubic fod	32·9716 ,,	5·2886 ,,	1·49749 ,,
Oxhoft	= $1\frac{1}{2}$ ahme = 7·265625 c. fod	49·4574 ,,	7·9329 ,,	2·24623 ,,
Fuder	= 4 oxehoved = $29\frac{1}{16}$ cubic fod	197·8298 ,,	31·7316 ,,	8·98491 ,,
Skieppe	= 18 pott = 0·5625 cubic foot	3·8290 gallons	0·61416 cub. foot	17·39015 litres
Korntoende	= 8 skieppe = 4·5 cubic feet	3·8290 bushels	4·91329 cub. feet	1·39121 hectol.
Korn-last	= 22 korntoende = 99·0 c. feet	10·5297 quarters	108·09230 ,,	30·60667 ,,

THE DANISH SYSTEM—(*continued*).

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Monetary lod .	= 4 quintin = 16 ort = 192 as .	0·518 968 ounce	0·519 595 ounce	14·7125 grammes
Monetary pound	= 2 mark = 16 ounces = 32 lod	1·037 936 pound	16·627 04 ounces	0·4708 kilog.
Commercial lod	= 4 quintin = 16 ort . .	0·550 494 ounce	0·551 159 ounce	15·6063 grammes
Commercial pound	= $\left\{\begin{array}{l}\frac{1}{62}\text{ foot-weight of water} = 2 \\ \text{mark} = 16\text{ oz.} = 32\text{ lod}\end{array}\right\}$	1·100 988 pound	17·637 10 ounces	0·4994 kilog.
Lispund . .	= 16 pounds	17·615 805 pounds	0·282 194 ft.-wt.	7·9904 ,,
Centner . .	= 100 pounds	0·983 025 cwt.	1·763 710 ,,	49·94 ,,
Skippund .	= 20 lispund = 320 pounds .	3·145 679 ,,	5·643 872 ,,	1·59808 quintal
Elsinor last of heavy goods = 12 skippund . .		1·887 407 ton	67·726 44 ,,	1·917696 millier
Last of heavy goods = $16\frac{1}{4}$ skippund = 5200 pounds .		2·555 865 tons	91·712 92 ,,	2·59688 milliers

N.B. The Norwegian standards are slightly lower; the foot 313·7 millimètres, the pot 0·9651 litre, the korntoende 138·97 litres, the commercial pound 0·4981 kilogramme, and the rest in proportion.

THE SWEDISH SYSTEM.

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Fot. . .	= 10 tum	0·974 277 foot	0·97400 foot	296·87 millim.
Aln . .	= 2 fot	1·948 555 ,,	1·94800 ,,	593·74 ,,
Famn . .	= 6 fot	1·948 555 yard	5·84400 feet	1·7812 mètre
Stöng . .	= 10 fot	9·742 77 feet	9·7400 ,,	2·9687 mètres
Ruthe . .	= 16 fot	5·196 087 yards	1·55840 rod	4·74987 ,,
Mil. . .	= 6000 famn	6·642 73 miles	3·50640 leagues	10·6872 kilom.
Square fot .	= 100 square tum . .	0·949 199 sq. foot	0·94866 sq. foot	8·81301 déc. carr.
Square åln .	= 4 square fot . . .	3·796 795 sq. feet	3·79463 sq. feet	35·25203 ,,
Square famn .	= 36 square fot . . .	3·796 795 sq. yards	34·15171 ,,	3·17268 mèt. car.
Square stöng .	= 100 square fot . . .	94·9199 sq. feet	94·866 ,,	8·81301 ,,
Square ruthe .	= 256 square fot . . .	26·9995 ,,	2·42857 sq. rods	22·56130 ,,
Tunneland .	= 56000 square fot . . .	1·22027 acre	5·31249 sq. chains	49·3528 ares
Square mil .	= 36 million square famn .	44·12585 sq. miles	12·2945 sq. leagues	144·2162 kilom. car.

Cubic fot	= 1000 cubic tum	0·924777	cub. foot	0·92399	cub. foot	26·16292	déc. cub.
Cord	= 108 cubic feet	3·699106	c. yards	99·79049	cub. feet	2·82560	mèt. cub.
Cubic famn	= 216 cubic feet	7·398211	,,	199·581	,,	5·65119	,,
Stop	= $\frac{1}{20}$ cubic foot	1·1521	quart	46·1993	fl. ounces	1·3081	litre
Kanne	= 2 stoppa = $\frac{1}{10}$,,	2·3042	quarts	92·3986	,,	2·6163	litres
Ankar	= 15 kannar = $1\frac{1}{2}$,,	8·6408	gallons	1·38598	cub. foot	39·2444	,,
Embar	= 2 ankar = 3 cubic feet	17·2816	,,	2·77196	cub. feet	78·4888	,,
Åm.	= 2 embar = 6 ,,	34·5633	,,	5·54392	,,	1·56978	hectol.
Fuder	= 6 åm = 4 oxhufwud = 36 c. feet	207·38	,,	33·2635	,,	9·4187	,,
Kappe	= $3\frac{1}{2}$ stop = $\frac{7}{40}$ cubic foot	1·0081	gallon	161·694	fl. ounces	4·5785	litres
Spann	= 16 kappar = 2·8 cubic feet	2·0162	bushels	2·58712	cub. feet	73·2562	,,
Tunna	= 2 spann = 5·6 ,,	4·0323	,,	5·17423	,,	1·14651	hectol.
Wholesale tunna	= $1\frac{1}{8}$ tunna = 6·3 cubic feet	4·5364	,,	5·82101	,,	1·64826	,,
Last of rye	= 24 wholesale tunna	13·6091	quarters	139·704	,,	39·5582	,,
Lod	= 4 quintin = $276\frac{1}{2}$ ass	204·256	grains	0·46431	ounce	13·2356	grammes
Skålpund	= 16 ounces = 32 lod	0·93375	pound	14·95800	ounces	423·54	,,
Jernwigt lb.	= $\frac{4}{5}$ skålpund (only lately abolished)	0·74693	pound	11·96525	ounces	338·8	grammes
Räjernwigt lb.	= 10168 ass (only lately abolished)	1·07497	,,	17·18858	,,	486·7	,,
Räkopparwigt lb.	= 7853 ass (only lately abolished)	0·82872	,,	13·27549	,,	375·9	,,
Landstadswigt lb.	= 7450 ass (only lately abolished)	0·78617	,,	12·48582	,,	356·6	,,
Bergwerkwigt lb.	= 7822 ass (only lately abolished)	0·82541	,,	13·22253	,,	374·4	,,
Lispund	= 20 skålpund	18·67491	pounds	0·29916	ft.-weight	8·4708	kilog.
Sten	= 32 skålpund	29·87985	,,	0·47866	,,	13·5533	,,
Centner	= 120 skålpund	1·00044	cwt.	1·79496	,,	50·8248	,,
Skippund	= 20 lispfund = 400 skålpund	3·33481	,,	5·98319	,,	1·6942	quintal
Last of heavy goods	= 5760 skålpund	2·40106	tons	86·1580	,,	2·43959	milliers

N.B. There were also 4 other lispund and 4 other skippund.

NORTH GERMAN SYSTEMS. *No. I. Prussia.*

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Rheinfuss (Danish) = 12 zoll	1·03000 foot	1·02971 foot	313·85 millim.
Feldfuss (divided decimally)	1·23600 ,,	1·23567 ,,	376·624 ,,
Elle = $25\frac{1}{2}$ zoll	2·18865 feet	2·18803 feet	666·90 ,,
Klafter = 6 fuss	2·06001 yards	6·17826 ,,	1·8831 mètre
Lachter = $6\frac{2}{3}$ fuss = 80 zollen	6·86669 feet	6·86474 ,,	2·0923 mètres
Ruthe = 12 fuss = 10 feldfuss	4·12001 yards	1·23567 rod	3·7662 ,,
Postmeile = 2000 ruthen	4·68190 miles	2·47130 leagues	7·5325 kilom.
Geographische meile 15 to 1°	4·50508 ,,	2·43079 ,,	7·4089 ,,
Quadratfuss = 144 quadr. zoll	1·06093 sq. foot	1·06033 league	9·85040 déc. carr.
Quadratfeldfuss	1·52774 ,,	1·52687 sq. foot	14·18458 ,,
Quadratklafter = 36 quadr. fuss	4·24372 sq. yards	38·17171 sq. feet	3·5461 mètres carr
Quadratruthe = {144 ,, = 100 quadr. feldfuss}	16·97491 ,,	1·52687 sq. rod	14·18458 ,,
Morgen = 180 quadr. ruthen	2·52519 roods	2·74837 sq. chains	25·5322 ares
Quadratmeile = 22 $222\frac{2}{9}$ morgen	21·92006 sq. miles	6·10748 sq. leagues	56·7383 kilom. carr.
Kubikzoll	1·09278 cub. inch	0·63185 fl. ounce	17·89111 cent. cub.
Kubikfuss = 1728 kub. zoll	1·09278 cub. foot	1·09184 cub. foot	30·91583 déc. cub.
Kubikklafter = 216 kub. fuss	8·74221 cub. yards	235·838 cub. feet	6·67782 mèt. cub.
Holzklafter = 108 ,,	4·37111 ,,	117·919 ,,	3·33891 ,,
Haufen = 486 ,,	19·56998 ,,	530·635 ,,	15·02509 ,,
Quart = 2 oessel = 64 kub. zoll	1·0084 quart	40·4375 fl. ounces	1·145 litre
Eimer = 2 anker = 60 quart = 3840 kub. zoll	15·1264 gallons	2·42625 cub. feet	68·70 litres
Ahm = 2 eimer = 7680 kub. zoll	30·2528 ,,	4·85250 ,,	1·374 hectol.
Fuder = 4 oxhoft = 6 ahme = $26\frac{2}{3}$ kub. fuss	181·5168 ,,	29·11499 ,,	8 244 ,,
Metze = 4 maesschen = 192 kub. zoll	3·0253 quarts	121·312 fl. ounce	3·435 litres
Scheffel = 16 metzen = 3072 kub. zoll	1·5126 bushel	1·9410 cub. foot	54·96 ,,
Malter = 12 scheffeln = $21\frac{1}{3}$ kub. fuss	2·2690 quarters	23·2920 cub. feet	0·5954 hectol.
Last (corn) = 6 maltern = 128 cubic feet	13·614 ,,	139·752 ,,	39·572 ,,
Winspel = 7 kub. fuss	5·9562 bushels	7·6429 ,,	2·1641 ,,

Loth .	= 4 quentchen = 16 pfennige = 32 heller	0·51556 ounce	0·51618 ounce	14·616 grammes
Mark .	= 8 unzen = 16 loth	0·51556 pound	8·25896 ounces	233·85 ,,
Pfund .	2 mark = 16 unzen = $\frac{1}{66}$ foot-weight of water at 15° R. . . .	1·03112 ,,	16·51792 ,,	467·71 ,,
Liespfund .	= $16\frac{1}{2}$ pfund . . .	17·01353 pounds	0·27255 ft. weight	7·7152 kilog.
Stein .	= 22 ,, . . .	22·68471 ,,	0·36339 ,,	10·2896 ,,
Centner .	= 110 ,, . . .	1·01271 cwt.	1·81697 ,,	51·4481 ,,
Schiffpfund .	= 3 centner . . .	3·03813 ,,	5·45091 ,,	154·344 ,,
Ton .	= 2000 pfund	0·92065 ton	33·03583 ,,	0·93542 millier
Last (heavy goods)	= 2 tons	1·84129 ,,	66·07166 ,,	1·87084 ,,
Also, last .	= 12 schiffpfund . . .	1·82288 ,,	65·41095 ,,	1·85213 ,,

NORTH GERMAN SYSTEMS. *No. II. Hamburg.*

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Hamburg fuss .	= 12 zoll	0·94021 foot	0·93994 foot	286·49 millim.
,, elle .	= 2 fuss	1·88042 ,,	1·87989 ,,	572·98 ,,
Klafter .	= 6 fuss	1·88042 yard	5·63967 feet	1·7189 mètre
Marschruthe .	= 14 fuss	4·38766 yards	1·31592 rod	4·01086 mètres
Geestruthe .	= 16 fuss	5·01447 ,,	1·50391 ,,	4·58385 ,,
Postmeile (Danish)	. . . . . .	4·68190 miles	2·47130 leagues	7·5325 ,,
Quadratfuss .	= 144 quadr. zoll . . .	0·88400 sq. foot	0·88350 sq. foot	8·20767 déc. carr.
Quadratklafter .	= 36 quadr. fuss . . .	3·53601 sq. yards	31·80635 cub. feet	2·95476 mèt. carr.
Marschruthe .	= 196 ,, . . .	19·25162 ,,	1·73166 sq. rod	16·08703 ,,
Morgen .	= 600 marschruthen . .	2·38656 acres	10·38994 sq. chains	96·5222 ares
Quadratmeile	. . . . . .	21·92006 sq. miles	6·10748 sq. leagues	56·7383 kilom. carr.

NORTH GERMAN SYSTEMS. *No. II. Hamburg*—(*continued*).

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Kubikzoll		0·83115 cub. inch	0·48058 fl. ounce	13·60774 cent. cub.
Kubikfuss	= 1728 kub. zoll	0·83115 cub. foot	0·83044 cub. foot	23·51417 déc. cub.
Kubikklafter	= 216 kub. fuss	6·64921 cub. yards	179·375 cub. feet	5·07906 mèt. cub.
Ton of measurement	= 40 kub. fuss	33·24606 cub. feet	33·2176 ,,	0·94057 ,,
Holzklafter	= $88\frac{8}{9}$ kub. fuss	2·73630 cub. yards	73·8170 ,,	2·09015 ,,
Stübchen	= 2 kannen or pots	3·1882 quarts	127·846 fl. ounces	3·62 litres
Anker	= 10 stübchen	7·9705 gallons	1·27846 cub. foot	36·20 ,,
Eimer	= 8 stübchen	6·3764 ,,	1·02277 ,,	28·96 ,,
Ahm	= 4 anker	31·8820 ,,	5·11384 cub. feet	1·4481 hectol.
Fuder	= 4 oxhoft = 6 ahme	191·292 ,,	30·68304 ,,	8·688 ,,
Himt	= 4 spint	5·8062 gallons	0·93130 cub. foot	26·37 litres
Fass	= 2 himten	1·4516 bushel	1·86260 ,,	52·74 ,,
Danish scheffel	=	3·8287 gallons	0·61411 ,,	17·39 ,,
Danish corn-barrel	= 8 scheffeln = $4\frac{1}{2}$k. Rheinfuss	3·8287 bushels	4·91289 cub. feet	1·3911 hectol.
Korn last	= 60 fässer	10·8868 quarters	111·756 ,,	31·644 ,,
Loth	= 4 quentchen = 16 pfennige	0·53396 ounce	0·53460 ounce	15·14 grammes
Mark	= 8 unzen = 16 loth	0·53396 pound	8·55368 ounces	242·2 ,,
Pfund	= 2 mark = 16 unzen	1·06792 ,,	17·10735 ,,	484·4 ,,
Liespfund	= 14 pfund	14·95086 pounds	0·23950 ft.-weight	6·7816 kilog.
Stein	= 20 pfund	21·35837 ,,	0·34215 ,,	9·688 ,,
Centner	= 112 pfund	1·06792 cwt.	1·91602 ,,	54·2528 ,,
Schiffpfund	= $2\frac{1}{2}$ centner	2·66980 ,,	4·79006 ,,	135·63 ,,
Frachtpfund	= 320 pfund	3·05120 ,,	5·47435 ,,	155·01 ,,
Ton	= 2000 pfund	0·95350 ton	34·21470 ,,	0·9688 millier
Schiffslast	= 2 tons	1·90700 ,,	68·42941 ,,	1·9376 ,,
Commerzlast	= $2\frac{1}{2}$,,	2·38375 tons	85·51176 ,,	2·4220 milliers

NORTH GERMAN SYSTEMS. *No. III. Bremen.*

			Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Bremen fuss	=	12 zoll or = 10 dec. zoll	0·94909 foot	0·94882 foot	289·20 millim.
,, elle	=	2 fuss	1·89818 feet	1·89764 feet	578·39 ,,
,, klafter	=	6 fuss	1·89818 yard	5·69292 ,,	1·7352 mètre
,, ruthe	=	16 fuss	5·06185 yards	1·51811 rod	4·62716 mètres
Postmeile (Danish)			4·68190 miles	2·47130 leagues	7·5325 kilom.
Quadratfuss	=	144 quad. zoll = 100 quad. dec. zoll	0·90079 square foot	0·90027 square ft.	8·36351 déc. carr.
Quadratklafter	=	36 quad. fuss	3·60314 square yards	32·40980 ,,	3·01086 mèt. carr.
Quadratruthe	=	256 ,,	25·62239 ,,	2·30470 sq. rods	21·41058 ,,
Morgen	=	120 quad. ruthen	2·54106 roods	2·76564 sq. chains	25·6927 ares
Quadratmeile	=		21·92006 square miles	6·10748 sq. leagues	56·7383 kilom. carr.
Kubikzoll			0·85494 cub. inch	0·49822 fl. ounce	13·99713 cent. cub.
Decimal kubikzoll			1·47733 cub. inches	0·85420 ,,	24·18704 ,,
Kubikfuss	=	1728 or 1000 kub. zoll	0·85494 cubic foot	0·85420 cub. foot	24·18704 déc. cub.
Kubikklafter	=	216 kub. fuss	6·84348 cub. yards	184·508 cub. feet	5·2244 mèt. cub.
Holzfaden	=	72 ,,	2·28116 ,,	61·503 ,,	1·74147 mèt. cub.
Stübchen	=	4 quarts	2·8442 quarts	113·649 fl. ounces	3·2180 litres
Anker	=	11¼ stübchen	7·9705 gallons	1·27846 cub. foot	36·20 ,,
Ahm	=	4 anker	31·882 ,,	5·11384 cub. feet	1·4481 hectol.
Fuder	=	4 oxhoft = 6 ahme	191·292 ,,	30·68304 ,,	8·688 ,,
Spint			1·0193 gallon	163·894 fl. ounce	4·63 litres
Scheffel	=	16 spint	2·0386 bushels	2·61590 cub. feet	74·07 ,,
Danish corn-barrel	=	4½ kub. Rheinfuss	3·8287 ,,	4·91289 ,,	1·3911 hectol.
Korn last	=	40 scheffeln	10·193 quarters	104·636 ,,	29·628 ,,
Loth	=	4 quentchen = 16 ort	0·54923 ounce	0·54989 ounce	15·57 grammes
Pfund	=	2 mark = 16 unzen = 32 loth	1·09845 ,,	17·59649 ounces	498·25 ,,
Liespfund	=	14½ pfund	15·92756 pounds	0·25515 ft.-weight	7·2246 kilog.
Stein	=	20 ,,	21·96905 ,,	0·35193 ,,	9·965 ,,
Centner	=	116 ,,	1·13768 cwt.	2·04119 ,,	57·797 ,,
Schiffpfund	=	2½ centner	2·84421 ,,	5·10298 ,,	144·4925 ,,
Frachtpfund	=	300 pfund	2·94228 ,,	5·27895 ,,	149·475 ,,
Last of heavy goods	=	4000 pfund	1·96152 ton	70·38594 ,,	1·993 millier

NORTH GERMAN SYSTEMS. *No. IV. Dresden.*

			Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Dresden fuss	=	12 zoll	0·92910 foot	0·92884 foot	283·11 millim.
,, elle	=	2 fuss	1·85821 ,,	1·85768 ,,	566·21 ,,
,, ruthe	=	16 fuss	4·95524 yards	1·48614 rod	4·52971 mètres
Klafter	=	6 fuss	1·85821 yard	5·57303 feet	1·6987 mètre
Lachter	=	7 fuss	2·16791 yards	6·50187 ,,	1·9818 ,,
Postmeile	=	1500 ruthen	4·22325 miles	2·22921 leagues	6·7946 kilom.
Polizeimeile	=	2000 ruthen	5·63096 ,,	2·97228 ,,	9·0594 ,,
Quadratfuss	=	144 quad. zoll	0·86324 sq. foot	0·86275 sq. foot	8·01493 déc. carr.
Quadratklafter	=	36 quad. fuss	3·45297 sq. yards	31·05904 sq. feet	2·88538 mèt. carr.
Quadratruthe	=	256 quad. fuss	24·5546 ,,	2·20864 sq. rods	20·51823 ,,
Acker	=	300 quad. ruthen	1·52197 acre	6·62593 sq. chains	61·55468 ares
Leipzig acker	=	300 quad. ruthen of Leipzig	1·51712 ,,	6·60482 ,,	61·3586 ,,
Quadratmeile	=	7500 acker	17·83581 sq. miles	4·95362 sq. leagues	46·16659 kilom. carr.
Kubikzoll	=		0·80205 cub. inch	0·46375 fl. ounce	13·13125 cent. cub.
Kubikfuss	=	1728 kub. zoll	0·80205 cub. foot	0·80136 cubic foot	22·69080 déc. cub.
Kubikklafter	=	216 kub. fuss	3·21638 cub. yards	173·094 cubic feet	4·90121 mèt. cub.
Visirkanne	=	$1\frac{1}{2}$ Dresden kanne	1·2369 quart	49·5977 fl. ounces	1·404 litre
Anker	=	24 visirkannen	7·4212 gallons	1·19035 cubic foot	33·71 litres
Ahm	=	2 eimer = 4 anker	29·6848 ,,	4·76138 cubic feet	1·3482 hectol.
Fuder	=	4 oxhoft = 6 ahme	178·1068 ,,	28·56829 ,,	8·0892 ,,
Metze	=	4 maesschen = 504 kub. zoll	1·4572 gallon	233·73 fl. ounces	6·6181 litres
Scheffel	=	16 metzen = 8064 kub. zoll	2·9144 bushels	3·73967 cubic feet	1·0589 hectol.
Malter	=	12 scheffeln	4·3715 quarters	44·87607 ,,	12·7068 ,,
Winspel	=	2 malter	8·7431 ,,	89·75215 ,,	25·4136 ,,
Loth	=	4 quintlein = 16 pfennige = 240 gran (Leipzig weight)	0·51533 ounce	0·51595 ounce	14·61 grammes
Mark	=	8 unzen = 16 loth (Leipzig weight)	0·51533 pound	8·25525 ounces	233·75 ,,
Pfund	=	2 mark = 16 unzen (Leipzig weight)	1·03066 ,,	16·51050 ,,	467·50 ,,
Butchers' pound		(Leipzig weight)	1·11157 ,,	17·8067 ,,	504·2 ,,
Miners' pound		(Leipzig weight)	0·99450 ,,	15·9312 ,,	451·1 ,,
Steel pound		(Leipzig weight)	0·96077 ,,	15·3909 ,,	435·8 ,,
Stein	=	22 pfund	22·67453 pounds	0·36323 ft.-weight	10·285 kilog.

NORTH GERMAN SYSTEMS. *No. V. Leipzig.*

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Leipzig fuss .	= 12 zollen	0·927642 foot	0·92738 foot	282·66 millim.
,, elle .	= 2 fuss	1·855284 ,,	1·85476 ,,	565·32 ,,
,, klafter	= 6 fuss	1·855284 yard	5·56428 feet	1·6959 mètre
,, lachter	= 7 fuss	2·164498 yards	6·49166 ,,	1·9786 ,,
,, ruthe .	= 16 fuss (used in masonry) .	4·947424 ,,	1·48381 rod	4·5225 mètres
,, postmeile	} Dresden miles { . . .	4·22325 miles	2·22921 leagues	6·7946 kilom.
,, polizeimeile	} Dresden miles { . . .	5·63096 ,,	2·97228 ,,	9·0594 ,,
Quadratfuss .	= 144 quad. zollen . . .	0·860493 sq. foot	0·86000 sq. foot	7·98941 déc. carr.
Quadratklafter	= 36 ,, fuss . . .	3·441973 sq. yards	30·96013 sq. feet	2·87619 mèt. carr.
Quadratruthe	= 256 ,, fuss . . .	24·4762 ,,	2·20161 sq. rods	20·45288 ,,
Acker. .	= 300 ,, ruthen . . .	1·51713 acre	6·60482 sq. chains	61·3586 ares
Kubikzoll .	. . . .	0·798219 cubic in.	0·46154 fl. ounce	13·06857 cent. cub.
Kubikfuss .	= 1728 kub. zollen . . .	0·798219 cubic foot	0·79754 cub. foot	22·58249 déc. cub.
Kubikklafter .	= 216 kub. fuss	6·385752 cub. yards	172·268 cub. feet	4·87782 mèt. cub.
Schragen .	= 3 holz-klafter = 378 kub. fuss	11·175071 ,,	301·469 ,,	8·53618 ,,
Visirkanne .	= 1$\frac{1}{7}$ Leipzig kanne . .	1·2369 quart	49·5977 fl. ounces	1·404 litre
Anker . .	= 27 visirkannen . . .	8·3490 gallons	1·3392 cub. foot	37·92 litres
Eimer . .	= 2 ankern	16·6980 ,,	2·67841 cub. feet	75·84 ,,
Ahm . .	= 2 eimer	33·3959 ,,	5·35682 ,,	1·5168 hectol.
Fuder . .	= 6 ähmen = 4 oxhoft . .	200 3754 ,,	32·14091 ,,	9·1008 ,,
Metze . .	= 4 maesschen } Dresden dry measures used since 1719 {	1·4572 gallon	233·73 fl. ounces	6·6181 litres
Scheffel . .	= 16 metzen } Dresden dry measures used since 1719 {	2·9144 bushels	3·7397 cub. feet	1·0589 hectol.
Malter . .	= 12 scheffeln } Dresden dry measures used since 1719 {	4·3715 quarters	44·8761 ,,	12·7068 ,,
Winspel . .	= 2 malter } Dresden dry measures used since 1719 {	8·7431 ,,	89·7521 ,,	25·4136 ,,
Loth . .	= { 4 quintlein = 16 pfennige = 240 gran . . }	0·51533 ounce	0·51595 ounce	14·61 grammes
Mark . .	= 8 unzen = 16 loth . . .	0·51533 pound	8·25525 ounces	233·75 ,,
Pfund . .	= 2 mark = 16 unzen . . .	1·03066 ,,	16·51050 ,,	467·5 ,,
Butchers' pound	=	1·11157 ,,	17·8067 ,,	504·2 ,,
Miners' pound	=	0·99450 ,,	15·9312 ,,	451·1 ,,
Steel pound	=	0·96077 ,,	15·3909 ,,	435·8 ,,
Stein . .	= 22 pfund	22·67453 pounds	0·36323 ft.-weight	10·285 kilog.
Centner . .	= 110 pfund	1·01226 cwt.	1·81616 ,,	51·425 ,,

NORTH GERMAN SYSTEMS. *No. VI. Brunswick.*

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Schuh	= 12 zoll	0·93650 foot	0·93624 foot	285·36 millim.
Elle	= 2 schuh	1·87301 ,,	1·87248 ,,	570·72 ,,
Ruthe	= 16 schuh	4·99472 yards	1·49798 rod	4·5658 mètres
Postmeile (Danish)		4·68190 miles	2·47130 leagues	7·5325 kilom.
Quadratzoll	=	0·87705 inch	0·00609 foot	5 65498 cent. carr.
Quadratschuh	= 144 quadratzoll	0·87705 sq. foot	0·87656 sq. foot	8·14317 déc. carr.
Quadratruthe	= 256 quadratschuh	24·82768 sq. yards	2·24398 sq. rods	20·84651 mèt. carr.
Morgen	= 120 quadratruthen	2·47411 roods	2·69278 sq. chains	25·0158 ares
Quadratmeile	=	21·92006 sq. miles	6·10748 sq. leagues	56·7383 kilom. carr.
Kubikzoll	=	0·82132 cubic in.	0·47490 fl. ounce	13·447 cent. cub.
Kubikschuh	= 1728 kubikzoll	0·82132 cubic foot	0·82062 cubic foot	23·236 déc. cub.
Holzklafter	= 2 maltern = 120⅓ kubikschuh	98·83139 cubic feet	98·74747 cubic feet	2·9958 mèt. cub.
Stübchen	= 4 quarts = 8 noesseln	3·2377 quarts	129·83 fl. ounce	3·676 litres
Anker	= 10 stübchen	8·0942 gallons	1·29833 cubic foot	36·762 ,,
Ahm	= 4 ankern	32·3768 ,,	5·19330 cubic feet	1·4705 hectol.
Fuder	= 4 oxhoft = 6 ahme	194·2608 ,,	31·15981 ,,	8·823 ,,
Vierfass	= 4 loechern	1·7119 gallon	274·61 fl. ounces	7·775 litres
Himt	= 4 vierfasse	6·8476 gailons	1·09845 cubic foot	31·10 ,,
Scheffel	= 10 himten	8·5595 busbels	10·98452 cubic feet	3·1103 hectol.
Last	= 10 scheffeln	10·6981 quarters	109·8452 ,,	31·103 ,,
Loth	= 4 quentchen = 16 pfennige = 32 heller	0·51511 ounce	0·51573 ounce	14·60 grammes
Mark	= 8 unzen = 16 loth	0·51511 pound	8·25172 ounces	233·65 ,,
Pfund	= 2 mark = 16 unzen	1·03022 ,,	16·50343 ,,	467·3 ,,
Liespfund	= 16 pfund	14·42307 pounds	0·23105 ft.-weight	6·5422 kilog.
Stein	= 20 pfund	20·60439 ,,	0·33007 ,,	9·3460 ,,
Centner	= 114 pfund	1·04862 cwt.	1·88139 ,,	53·2722 ,,
Schiffpfund	= 20 liespfund	2·57547 ,,	4·62096 ,,	130·84 ,,

NORTH GERMAN SYSTEMS. *No. VII. Hanover.*

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Fuss	= 12 zoll = 96 achteln	0·95829 foot	0·95802 foot	292·0 millim.
Elle	= 2 fuss	1·91659 ,,	1·91605 ,,	584·0 ,,
Klafter	= 6 fuss	1·91659 yard	5·74814 feet	1·752 mèt.
Ruthe	= 16 fuss	5·11090 yards	1·53284 rod	4·67191 ,,
Post meile	= 25400 fuss	4·60992 miles	2·43334 leagues	7·4167 kilom.
Polizeimeile	= 2274 ruthen	6·58095 ,,	3·47375 ,,	10·5878 ,,
Geviertefuss	= 144 geviertezoll	0·91830 square foot	0·91777 square foot	8·52608 déc. carr.
Gevierteklafter	= 36 geviertefuss	3·67318 sq. yards	33·03982 square feet	3·06939 mèt. carr.
Gevierteruthe	= 256 geviertefuss	26·1204 ,,	2·34950 sq. rods	21·82676 ,,
Vorling	= 60 gevierteruthen	1·29523 rood	1·40970 sq. chain	13·096 ares
Morgen	= $1\frac{1}{3}$ drohn = 2 vorling	2·59045 roods	2·81940 sq. chains	26·1921 ,,
Kubikzoll		0·87998 cubic inch	0·50881 fl. ounce	14·40144 cent. cub.
Kubikfuss	= 1728 kubikzoll	0·87998 cubic foot	0·87923 cubic foot	24·89568 déc. cub.
Kubikklafter	= 216 kubikfuss	7·01986 cubic yards	189·01374 cubic feet	5·37747 mèt. cub.
Pot or kanne	= 2 quart = 4 noesseln	1·7121 quart	68·6554 fl. ounces	1·944 litre
Stübchen	= 2 kannen	0·8561 gallon	137·3108 ,,	3·888 litres
Anker	= 5 vierteln = 10 stübchen	8·5605 gallons	1·37311 cubic foot	38·88 ,,
Ahm	= $2\frac{1}{2}$ eimer = 4 anker	34·242 ,,	5·49243 cubic feet	1·5552 hectol.
Fuder	= 4 oxhoft = 6 ahm	205·452 ,,	32·95459 ,,	9·3312 ,,
Himt	= 3 dritteln = 4 vierfasse	6·8476 gallons	1·09845 cubic foot	31·10 litres
Malter	= 6 himten	5·1357 bushels	6·59071 cubic feet	1·8662 hectol.
Winspel	= 8 maltern	5·1357 quarters	52·7257 ,,	14·9296 ,,
Last	= 2 winspeln	10·2714 ,,	105·4514 ,,	29·8592 ,,
Pfund	= 2 marc = 16 unzen = 32 loth = 128 quentchen = 512 oertlein	1·07938 pound	17·2910 ounces	489·6 grammes
Wool stein	= 10 pfund	10·79383 pounds	172·91 ,,	4·896 kilog.
Liespfund	= 14 ,,	15·11136 ,,	242·074 ,,	6·85 ,,
Stein for flax & hemp	= 20 ,,	21·58765 ,,	345·82 ,,	9·792 ,,
Centner	= 8 liespfund = 112 pfund	1·07938 cwt.	1·93659 ft.-weight	54·84 ,,
Schiffpfund	= $2\frac{1}{2}$ centner	2·69846 ,,	5·84148 ,,	137·09 ,,
Pfundschwer	= 3 ,,	3·23815 ,,	5·80978 ,,	164·51 ,,
Last	= 30 ,,	1·61907 ton	58·09776 ,,	1·6451 millier

NORTH GERMAN SYSTEMS. *No. VIII. Gotha.*

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Fuss	= 12 zoll	0·94385 foot	0·94359 foot	287·6 millim.
Elle		1·84652 ,,	1·84600 ,,	562·65 ,,
Feldruthe	= 14 fuss	4·40493 yards	1·32102 rod	4·0267 mètres
Waldruthe	= 16 fuss	5·03421 ,,	1·50974 ,,	4·6019 ,,
Quadratfuss	= 144 quadratzoll	0·89098 sq. foot	0·89047 sq. foot	8·27242 déc. carr.
Quadratfeldruthe	= 196 quadratfuss	19·40350 sq. yards	1·74532 sq. rod	16·21395 mèt. carr.
Quadratwaldruthe	= 256 ,,	25·34334 ,,	2·27960 sq. rods	21·17740 ,,
Feldacker	= 140 quadratruthen	2·24502 roods	2·44344 sq. chains	22·6995 ares
Waldacker	= 160 ,,	3·35117 ,,	3·64735 ,,	33·8838 ,,
Kubikzoll		0·84101 cub. inch	0·48628 fl. ounce	13·76909 cent. cub.
Kubikfuss	= 1728 kubikzoll	0·84101 cub. foot	0·84029 cub. foot	23·79300 déc. cub.
Holz-klafter	= 108 kubikfuss	3·36402 cub. yards	90·75102 cub. feet	2·56964 mèt. cub.
Bergscheffel	= 2920 kubikzoll	1·1064 bushel	1·41972 cub. foot	40·20 déc. cub.
Charcoal malter	= $42\frac{7}{8}$ kubikfuss	1·3355 cub. yard	36·02750 cub. feet	1·02013 mèt. cub.
Mass (oil)	= 1 pfund	0·8807 pint	17·6583 fl. ounces	0·500 litre
Stübchen	= 4 schenkmass	3·2049 quarts	128·5170 ,,	3·639 litres
Eimer	= 20 stübchen	16·0247 gallons	2·5703 cub. feet	72·78 ,,
Ahm	= 2 eimer	32·0494 ,,	5·1407 ,,	1·4556 hectol.
Fuder	= 6 ahme	192·2964 ,,	30·8441 ,,	8·7336 ,,
Metze	= 4 maesschen	2·4284 gallons	389·506 fl. ounces	11·029 litres
Scheffel	= 8 metzen	2·4284 bushels	3·11605 cubic feet	88·232 ,,
Malter	= 2 scheffeln = 4 vierteln	4·8567 ,,	6·23210 ,,	176·464 ,,
Pfund		1·03044 pounds	16·5069 ounces	467·4 grammes
Centner	= 110 pfund	1·01204 cwt.	1·81576 ft.-weight	51·414 kilog.
Coburg units.				
Elle of Coburg		1·92414 foot	1·92359 foot	586·3 millim.
Biermass ,,		1·6804 pint	33·6920 fluid oz.	0·954 litre
Pfund ,,		1·12391 pound	17·9944 ounces	0·5098 kilog.
Centner = 110 pfund		1·10385 cwt.	1·97938 ft.-weight	56·078 ,,

NORTH GERMAN SYSTEMS. *No. IX. Oldenburg.*

		Eng. Commercial Equiv.		Eng. Scientific Equiv.		French Equivalent.	
Fuss	= 12 zoll	0·97273	foot	0·97246	foot	296·4	millim.
Elle	=	1·89690	,,	1·89636	,,	578·0	,,
Ruthe	18 fuss	5·83641	yards	1·75043	rod	5·33549	mètres
Post mile (Danish)		4·68190	miles	2·47130	leagues	7·5325	kilom.
Geographische meile ($11\frac{1}{4}$ to 1°)		6·14014	,,	3·24107	,,	9·8786	,,
Quadratfuss	= 144 quad. zoll	0·94632	sq. foot	0·94578	sq. foot	8·78624	déc. carr.
Juck or quad. ruthe	= 324 quad. fuss	34·06737	sq. yards	3·06432	sq. rods	28·46742	mèt. carr.
Morgen	= 356 juck	3·09355	acres	13·46787	sq. chains	1·25116	hectare
Square mile (Danish)		21·92006	sq. miles	6·10748	sq. leagues	56·7383	kilom. carr.
Kubikzoll		0·92042	cub. inch	0·53219	fl. ounce	15·06923	cent. cub.
Kubikfuss	= 1728 kubikzoll	0·92042	cub. foot	0·91963	cub. foot	26·03962	déc. cub.
Quart		1·6806	pint	33·6955	fl. ounces	0·9541	litre
Bierkanne	= $1\frac{7}{13}$ quart	1·2057	quart	48·3484	,,	1·369	,,
Anker	= 40 quarts	8·4032	gallons	1·34782	cub. foot	38·164	litres
Ahm	= 4 anker	33·6127	,,	5·39128	cub. feet	1·5266	hectol.
Fuder	= 4 oxhoft = 6 ahme	201·6762	,,	32·34770	,,	9·1596	,,
Scheffel	= 16 bierkannen	4·8217	gallons	0·77339	cub. foot	21·90	litres
Kornfass	= 8 scheffeln	4·8217	bushels	6·18711	cub. feet	1·7519	hectol.
Molt	= 12 ,,	7·2325	quarters	9·28068	,,	2·6279	,,
Last	= $1\frac{1}{2}$ molt	10·849	,,	111·37	,,	31·535	,,
Loth	= 4 quentchen = 16 pfennige = 256 as	0·533959	ounce	0·53460	ounce	15·14	grammes
Mark	= 8 unzen = 16 loth	0·533959	pound	8·55368	ounces	242·2	,,
Pfund	= 2 mark = 16 unzen	1·067919	,,	17·10735	,,	484·4	,,
Liespfund	= $14\frac{1}{2}$ pfund	15·484820	pounds	0·24036	ft.-weight	7·0238	kilog.
Stein	= 20 ,,	21·358372	,,	0·34215	,,	9·688	,,
Centner	= 100 ,,	0·953499	pound	1·71074	,,	48·44	,,
Schiffpfund	= 20 liespfund	2·765147	cwt.	4·80717	ft.-weights	140·476	,,
Pfundschwer	= 300 pfund	2·860497	,,	5·13221	,,	145·32	,,

NORTH GERMAN SYSTEMS. *No. X. Mecklenburg.*

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Rostock fuss . = 12 zoll		0·95501 foot	0·95474 foot	291·0 millim.
Hamburg elle		1·880423 ,,	1·87959 ,,	572·98 ,,
Rostock ruthe . = 16 fuss		5·09343 yards	1·52759 rod	4·65603 mètres
Post meile (Danish)		4·68190 miles	2·47130 leagues	7·5325 kilom.
Quadratfuss . = 144 quadratzoll		0·91206 sq. foot	0·91154 sq. foot	8·46821 déc. carr.
Quadratruthe . = 256 quadratfuss . . .		25·94313 sq. yards	2·33355 sq. rods	21·67863 mèt. carr.
Acker . . = 100 quadratruthen . .		2·14406 roods	2·33355 sq. chains	21·67863 ares
Hufe . . = 400 acker		2·14406 hides	9·3342 centuries	86·7145 hectares
Quadratmeile (Danish)		21·92006 sq. miles	6·10748 sq. leagues	56·7383 kil. carr.
Kubikzoll		0·87102 cub. inch	0·50363 fl. ounce	14·26052 cent. cub.
Kubikfuss . = 1728 kubikzoll . . .		0·87102 cub. foot	0·87028 cub. foot	24·64217 déc. cub.
Holzfaden . = 98 kubikfuss . . .		3·06153 cub. yards	82·59058 cub. feet	2·33858 mèt. cub.
Rostock stübchen = 2 kannen = 4 quarts . .		3·1882 quarts	127·846 fl. ounces	3·620 litres
,, anker . = 10 stübchen . . .		7·9705 gallons	1·27846 cub. foot	36·20 ,,
,, ahm . = 4 anker		31·8820 ,,	5·11384 cub. feet	1·4481 hectol.
,, fuder . = 4 oxhoft = 6 ahme . .		191·392 ,,	30·68304 ,,	8·688 ,,
,, metze or spint		2·1407 quarts	85·841 fl. ounces	2·431 litres
,, scheffel = 16 metzen		1·0704 bushel	1·37346 cub. foot	38·89 ,,
,, droemt = 12 scheffeln . . .		1·6055 quarter	16·48154 cub. feet	4·6668 hectol.
,, last = 8 droemten . . .		12·8442 quarters	131·852 ,,	37·336 ,,
Loth . = 4 quentchen = 16 pfennige	Hamburg.	0·53396 ounce	0·53460 ounce	15·14 grammes
Mark . = 8 unzen = 16 loth .		0·53396 pound	8·55368 ounces	242·2 ,,
Pfund . = 2 mark = 16 unzen .		1·06792 ,,	17·10735 ,,	484·4 ,,
Liespfund = 14 pfund . . .		14·95086 pounds	0·23950 ft.-weight	6·7816 kilog.
Stein . = 20 ,, . . .		21·35837 ,,	0·34215 ,,	9·688 ,,
Centner . = 112 ,, . . .		1·06792 cwt.	1·91602 ,,	54·2528 ,,
Schiffpfund = 2½ centner . . .		2·66980 ,,	4·79006 ,,	135·63 ,,
Frachtpfund = 320 pfund . . .		3·05120 ,,	5·47435 ,,	155·008 ,,

SOUTH GERMAN SYSTEMS. *No. I. Austro-Hungarian Empire.*

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Faust		1·03732 hand	0·34568 foot	10·53602 centim.
Fuss	= 3 fausten = 10 dec. zoll = 12 zoll	1·03732 foot	1·03703 ,,	0·31608 mètre
Elle		2·55181 feet	2·55110 feet	0·77756 ,,
Klafter	= 6 fuss	2·07463 yards	6·22217 ,,	1·89648 ,,
Postmeile	= 4000 klafter	4·71512 miles	2·48887 leagues	7·58594 kilom.
Quadratfuss	= 100 dec. quadratzoll = 144 quadratzoll	1·07604 sq. foot	1·07543 sq. foot	0·09991 mèt. carr.
Quadratklafter	= 36 quadratfuss	4·30417 sq. yards	38·71544 sq. feet	3·59665 ,,
Joch	= 1600 quadratklafter	1·42286 acre	6·19447 sq. chains	57·54642 ares
Quadratmeile	= 10000 joch	22·2323 sq. miles	6·19447 sq. leagues	57·54642 kilom. car.
X Kubikzoll		1·11622 cub. inch	0·64541 fl. ounce	18·2749 cent. cub.
Decimal kubikzoll		1·92882 ,,	1·11526 ,,	31·579 ,,
Kubikfuss	= 1000 dec. kub. zoll = 1728 kub zoll	1·11622 cub. foot	1·11526 cub. foot	0·03158 mèt. cub.
Kubikklafter	= 216 kubikfuss	8·92965 cub. yards	240·863 cub. feet	6·82099 ,,
Mass	= 2 kannen = 3 seideln	1·2460 quart	49·963 fl. ounces	1·41472 litre
Viertel	= 10 mass	3·1149 gallons	499·63 ,,	14·1472 litres
Eimer	= 4 vierteln	12·4598 ,,	1·99853 cub. foot	0·56589 hectol.
Fuder	= 32 eimer	398·713 ,,	63·95296 cub. feet	18·10848 ,,
Muhlmassl	= 2 futtermassl = 8 becher	3·3845 quarts	135·719 fl. ounces	3·84293 litres
Metze	= 4 vierteln = 8 achteln = 16 muhlmassl	1·6923 bushel	2·17150 cub. feet	0·61487 hectol.
Muth	= 30 metzen	6·3460 quarters	65·1451 ,,	18·44604 ,,
Carat		3·1786 grains	7·2742 miis	0·20597 gramme
Ducat	60 mandel	53·8727 ,,	123·2866 ,,	3·49090 grammes
Loth	= 4 quinten = 16 pfennige	270·095 ,,	618·106 ,,	17·50187 ,,

SOUTH GERMAN SYSTEMS. *No. I. Austro-Hungarian Empire*—(*continued*).

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Postloth		257·206 grains	588·610 mils	16·66667 grammes
Mark of silver wt.	= $80\frac{2}{5}$ ducats	9·9003 ounces	9·91223 ounces	0·28067 kilog.
Pfund	= 16 unzen = 32 loth	1·23472 pound	19·77940 ,,	0·56006 ,,
Zollpfund	= 30 postloth	1·10231 ,,	17·65829 ,	0·5 ,,
Medicinal pfund	= 12 unzen	0·92604 ,,	14·83455 ,,	0·42005 ,,
Stein	= 20 pfund	24·79460 pounds	0·39559 ft.-weight	11·2012 ,,
Centner	= 100 ,,	1·07564 cwt.	1·99794 ,,	56·066 ,,
Zollcentner	= 100 zollpfund	110·23107 pounds	1·76583 ,,	50 ,,
Karch	= 400 pfund	4·40972 cwt.	7·91176 ,,	2·24024 quintals

SOUTH GERMAN SYSTEMS. *No. II. Bavaria.*[1]

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Zoll		0·95783 inch	0·07980 foot	2·43216 centim.
Fuss	= 12 zoll = 10 decimal zoll	0·95783 foot	0·95756 ,,	0·29186 mètre
Klafter	= 6 fuss	5·74698 feet	5·74596 feet	1·75116 ,,
Ruthe	= 10 fuss	9·57832 ,,	0·95756 rod	2·91859 mètres
Stunde	= 12703 fuss	2·30443 miles	1·21619 league	3·70749 kilom.
Quadratfuss		0·91744 sq. foot	0·91692 sq. foot	8·51818 déc. carr.
Quadratklafter	= 36 quadratfuss	3·66978 sq. yards	33·00919 sq. feet	3·06655 mèt. carr.
Quadratruthe	= 100 ,,	10·19383 ,,	0·91692 sq. rod	8·51818 ,,
Tagwerk	= 400 quadratruthen	0·84246 acre	3·66769 sq. chains	34·07271 ares

[1] For the System of Rhenish Bavaria see the French mesures usuelles among Metric Systems.

Kubikzoll . .	. . . .	0·87876 cub. inch	0·50811 fl. ounce	14·3872 cent. cub.
Decimal kubikzoll	. . . .	1·51850 ,,	0·87801 ,,	24·86108 ,,
Kubikfuss . .	= 1000 dec. kub. zoll = 1728 kub. zoll .	0·87876 cub. foot	0·87801 cub. foot	24·86108 déc. cub.
Holzklafter . .	= 126 kubikfuss	4·10087 cub. yards	110·629 cub. feet	3·13249 mèt. cub.
Kubikklafter .	= 216 ,, ...	7·03008 ,,	189·650 ,,	5·36999 ,,
Masskanne . .	= 43 decimal kub. zoll	0·9415 quart	37·7545 fl. ounces	1·0690 litre
Schankeimer .	= 60 masskannen = 2580 dec. kub. zoll	14·1228 gallons	2·26527 cub. feet	64·1418 litres
Eimer . . .	= 64 masskannen = 2752 dec. kub. zoll	15·0643 ,,	2·41629 ,,	68·4177 ,,
Dreissiger . .	= $46\frac{7}{12}$ dec. kub. zoll .	1·0198 quart	40·901 fl. ounces	1·1581 litre
Massl . . .	= 4 dreissiger = $186\frac{1}{3}$ dec. kub. zoll .	1·0198 gallon	163·602 ,,	4·6325 litres
Metze . . .	= 8 massl = $1490\frac{2}{3}$ dec. kub. zoll .	1·0198 bushel	1·30882 cub. foot	37·0596 ,,
Scheffel . .	= 6 metzen = 8944 dec. kub. zoll .	6·1199 bushels	7·85291 cub. feet	2·2236 hectol.
Carat (Dutch) .	= 4 Troy Dutch grains .	3·17743 grains	7·2715 mils	0·20589 gramme
Kölnische ducat, for gold weight	. . . .	53·86476 ,,	123·2682 ,,	3·49038 grammes
Loth . . .	= 4 quentchen = 16 pfennige = 272 as .	0·61729 ounce	0·61804 ounce	17·5 ,,
Mark . . .	= 8 unzen = 16 loth . .	0·61729 pound	9·88864 ounces	0·280 kilog.
Pfund . . .	= 2 mark = 16 unzen .	1·23459 ,,	19·77729 ,,	0·560 ,,
Medicinal pfund .	= 12 unzen . . .	0·79366 ,,	12·71397 ,,	0·360 ,,
Stein . . .	= 20 pfund . . .	24·69176 pounds	0·39555 ft.-weight	11·2 ,,
Centner . .	= 100 ,, . . .	1·10231 cwt.	1·97773 ,,	56·0 ,,

SOUTH GERMAN SYSTEMS. *No. III. Würtemberg,*[1] *since* 1806.

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	Metric Equivalent.
Fuss	= 10 zoll (Hamburg value)	0·94021 foot	0·93994 foot	286·49 millim.
Elle		2·01586 feet	2·01529 feet	614·25 ,,
Klafter	= 6 fuss	1·88042 yard	5·63967 ,,	1·71894 mètre
Ruthe	= 10 ,,	9·40212 feet	0·93994 rod	2·86490 mètres
Quadratfuss	= 100 quadratzoll	0·88400 sq. foot	0·88350 sq. foot	8·20767 déc. carr.
Quadratklafter	= 36 quadratfuss	3·53601 sq. yards	31·80635 sq. feet	2·95476 mèt. carr.
Quadratruthe	= 100 ,,	9·82224 ,,	0·88350 sq. rod	8·20767 ,,
Morgen	= 384 quadratruthen	0·77928 acre	3·39263 sq. chains	31·5174 ares
Kubikzoll		1·436229 cub. inch	0·83044 fl. ounce	23·51417 cent. cub.
Kubikfuss	= 1000 kubikzoll	0·831152 cub. foot	0·83044 cub. foot	23·51417 déc. cub.
Scheitholzklafter	= 144 kubikfuss	4·432808 cub. yards	119·583 cub. feet	3·38604 mèt. cub.
Kubikklafter	= 216 ,,	6·649214 ,,	179·375 ,,	5·07906 ,,
Quart or schoppen	hellaichmass = $10\frac{17}{32}$ kub. zoll	0·8089 pint	16·2198 fl. ounces	0·4593 litre
Mass or pot	= 4 schoppen = $78\frac{1}{8}$,,	1·6179 quart	64·8782 ,,	1·8370 ,,
Imi	= 10 mass = $781\frac{1}{4}$,,	4·0447 gallons	0·64878 cub. foot	18·3705 litres
Ahm or eimer	= 16 imi = 1250 ,,	64·7152 ,,	10·38050 cub. feet	2·93927 hectol.
Fuder	= 6 ahm = 7500 ,,	388·2912 ,,	62·28302 ,,	17·636 ,,
Achtel	= 4 ecklein = $117\frac{49}{64}$,,	2·4389 quarts	195·599 fl. ounce	2·770 litres
Simri	= 8 achtel = $942\frac{1}{8}$,,	4·8778 gallons	0·78239 cub. foot	22·15 ,,
Scheffel	= 8 simri = 7537 ,,	4·8778 bushels	6·25916 cub. feet	1·7723 hectol.
Loth	= 4 quenten (Prussian values)	0·51556 ounce	0·51618 ounce	14·616 grammes
Cölnische mark	= 8 unzen = 16 loth (Prussian values)	0·51556 pound	8·25896 ounces	233·85 ,,
Pfund	= 2 mark = 16 unzen (Prussian values)	1·03112 ,,	16·51792 ,,	467·71 ,,
Centner	= 100 pfund	0·92065 cwt.	1·65179 ft.-weight	46·771 kilog.
Wholesale centner	= 104 ,,	0·95747 ,,	1·71786 ,,	48·6418 ,,

[1] For the Systems of Baden and Hesse see Metric Systems.

THE SPANISH SYSTEM. *Castilian Measures.*

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	Metric Equivalent.
Pie castillan = 12 pulgadas = 16 dedos . .	0·913432 foot	0·91318 foot	278·33 millim.
Codo or dinario = 1½ pie	1·370148 ,,	1·36978 ,,	417·50 ,,
Codo de ribera = 2 pies	1·826863 ,,	1·82637 ,,	556·67 ,,
Vara . . = 3 ,, ...	0·913432 yard	2·73955 feet	0·835 mètre
Braza o estado = 6 ,, ...	1·826863 ,,	5·47910 ,,	1·670 ,,
Estadal . = 12 ,, ...	3·653727 yards	1·09582 rod	3·340 mètres
Estadio . = 625 ,, = 125 pasos . .	0·865025 furlong	5·70740 chains	173·9583 ,,
Milla . . = 5000 ,, = 1000 ,, . .	0·865025 mile	0·45659 league	1·3917 kilom.
Pie cuadrado . = 144 pulgadas cuad. . . .	0·834381 sq. foot	0·83390 sq. foot	7·74694 déc. carr.
Vara cuadrada = 9 pies cuad. . . .	0·834381 sq. yard	7·50514 sq. feet	0·69723 mèt. carr.
Estadal . = 16 varas cuad. . . .	13·350096 sq. yards	1·20082 sq. rod	11·1556 ,,
Celemin . = {48 estadales cuad. = 768 var. cuad. . . .}	0·52959 rood	57·6395 sq. rods	5·35469 ares
Fanegada . = 12 celemines = 9216 var. cuad.	1·58877 acre	6·91674 sq. chains	64·2563 ,,
Yugada . = 50 fanegadas	78·4385 acres	345·837 ,,	32·12813 hectares
Pulgada cubica	0·762160 cub. inch	0·44069 fl. ounce	12·47820 cent. cub.
Pie cubico . = 1728 pulgadas cubicas . .	0·762160 cub. foot	0·76151 cub. foot	21·56233 déc. cub.
Vara cubica . = 27 pies cubicos . . .	0·762160 cub. yard	20·91388 cub. feet	0·58218 mèt. cub.
Azumbre	1·7765 quart	71·238 fl. ounces	2·017 litres
Cantara o arroba mayor = 8 azumbres . . .	3·5531 gallons	0·56990 cub. foot	16·137 ,,
Pipa vino . = 27 arrobas mayores . .	95·9324 ,,	15·38740 cub. feet	4·3570 hectol.
Bota vino . = 30 ,, . .	106·5915 ,,	17·09711 ,,	4·8411 ,,
Arroba menor of oil	2·7663 ,,	0·44372 cub. foot	12·564 litres
Pipa of oil = 34½ arrobas	95·441 ,,	15·30867 cub. feet	4·3347 hectol.
Bota ,, = 38½ ,, ...	106·508 ,,	17·08368 ,,	4·8373 ,,
Tonelada vino = 2 botas (or 60 arrobas) .	213·183 ,,	34·1942 ,,	9·682 ,,
Almude or celemin = 16 ochavos	1·0055 gallon	161·291 fl. ounces	4·567 litres

THE SPANISH SYSTEM. *Castilian Measures—(continued).*

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	Metric Equivalent.
Fanega . . = 12 almudes	1·5082 bushel	1·93549 cub. foot	54·80 litres
Cahiz . . = 12 fanegas	2·2623 quarters	23·22588 cub. feet	6·576 hectol.
Dracma = 3 escrupulos = 6 obolos = 72 granos . Ochava = { 2 adarmes o arienzos = 6 tomines = 18 caracters . . . . . }	55·46001 grains	126·919 mil	3·5938 grammes
Marc (med. and mon.) = { 8 onzas = 32 quartos = 64 ochavas o dracmas }	0·507063 pound	8·12281 ounces	0·230 kilog.
Libra . . = 2 marcos = 16 onzas . .	1·014126 ,,	16·24563 ,,	0·460 ,,
Arroba . . = 25 libras	25·353145 pounds	0·40614 ft.-weight	11·5 ,,
Quintal . = 100 ,, ...	0·905470 cwt.	1·62456 ,,	46 ,,
Tonelada . = 20 quintals	0·905470 ton	32·49126 ,,	0·920 millier

THE PORTUGUESE SYSTEM. *Lisbon Measures.*

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	Metric Equivalent.
Pé . . = { $1\frac{1}{2}$ palmos = 12 pollegadas = 18 dedos . . . }	1·083004 foot	1·08270 foot	330 millim.
Covado . = 2 pés	2·166008 feet	2·16539 feet	660 ,,
Vara . = $1\frac{2}{3}$ covado = $3\frac{1}{3}$ pés = 5 palmos .	1·203337 yard	3·60899 ,,	1·100 mètre

Paso	= $1\frac{1}{2}$ vara = 5 pés	5·415020	feet	5·41348	,,	1·650	,,
Braça	= 2 varas	2·406674	yards	7·21798	,,	2·200	mètres
Milha	= { 8 estadios = $946\frac{2}{3}$ braças, or 54 to 1° }	1·27917	mile	0·67521	league	2·0580	kilom.
Legoa	= { 24 estadios = 2840 braças, or 18 to 1° }	3·83751	miles	2·02563	leagues	6·1741	,,
Square pé	= 144 sq. pollegadas	1·172900	sq. foot	1·17223	sq. foot	10·890	déc. carr.
,, vara	= $11\frac{1}{9}$ sq. pés = 25 sq. palmos	1·448026	sq. yard	13·02480	sq. feet	1·210	mèt. carr.
Geira	= 4840 sq. varas	1·448026	acre	6·30400	sq. chains	58·564	ares
Cubic pollegada		1·270258	cub. inch	0·73447	fl. ounce	20·796881	cent. cub.
,, pé	= 1728 cubic pollegadas	1·270258	cub. foot	1·26917	cub. foot	35·937	déc. cub.
,, vara	= $37\frac{1}{27}$ cub. pés = 125 cub. palmos	1·742468	cub. yard	47·00637	cub. feet	1·3310	mèt. cub.
Canhada	= 4 quartilhos	1·2139	quart	48·678	fl. ounces	1·38	litre
Almude	= 2 alqueiras = 12 canhadas	3·6418	gallons	0·58414	cub. foot	16·54	litres
Pipa o bota	= 26 almudes	94·6863	,,	15·18754	cub. feet	4·3013	hectol.
Tonelada	= 2 pipas	189·3726	,,	30·37509	,,	8·603	,,
Alqueira (dry)	= 8 outavas	2·9768	,,	0·47748	cub. foot	13·52	litres
Fanga	= 4 alqueiras (dry)	1·4884	bushel	1·90992	,,	54·08	,,
Moco	= 15 fangas	2·7908	quarters	28·64881	cub. feet	8·1123	hectol.
Outava	= 3 escrupulos = 72 grãos	55·09827	grains	126·091	mils	3·5703	grammes
Marco (med. & mon.)	= 8 onzas = 64 outavas	0·505961	pound	8·10515	ounces	229·5	,,
Arratel o libra	= 2 marcos = 16 onzas	1·011921	,,	16·21031	,,	459·0	,,
Arroba	= 32 arrateis	32·381478	pounds	0·51873	ft.-weight	14·688	kilog.
Quintal	= 4 arrobas = 128 arrateis	1·156482	cwt.	2·07492	,,	58·752	,,
Tonelada	= 1728 arrateis	0·780635	ton	28·01142	,,	0·79315	millier

THE OLD PARISIAN MEASURES *used till* 1812 (*also used in Quebec till* 1870).

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	Metric Equivalent.
Parisian pouce . . .	= 12 lignes . . .	1·066074 inch	0·08881 foot	27·0699 millim.
,, pied . . .	= 12 pouces . . .	1·066074 foot	1·06577 ,,	324·839 ,,
,, perche . . .	= 18 pieds . . .	6·396444 yards	1·91838 rod	5·84711 mètres
,, arpent . . .	= 10 perches . . .	63·96444 ,,	1·91838 chain	58·47109 ,,
Toise . . .	= 6 pieds . . .	2·132148 ,,	6·39461 feet	1·94904 mètre
Mille itinéraire . .	= 1000 toises . . .	1·211443 mile	0·63946 league	1·94904 kilom.
Pied carré . . .	= 144 pouces carrés . .	1·136493 sq. foot	1·13586 sq. foot	0·10552 mèt. carr.
Toise carrée . . .	= 36 pieds carrés . .	4·545972 sq. yards	40·89096 sq. feet	3·79876 ,,
Perche de Paris . .	= 324 ,, . . .	0·033813 rood	3·68020 sq. rods	34·1887 ,,
Arpent de Paris . .	= 100 perches de Paris	0·845335 acre	3·68020 sq. chains	0·34189 hectare
Perche des eaux et forêts	= 484 pieds carrés . .	0·050511 rood	5·49755 sq. rods	51·072 mèt. carr.
Arpent des eaux et forêts	= 100 perches d. e. et forêts	1·26278 acre	5·49755 sq. chains	0·51072 hectare
Pouce cube . . .	. . . .	1·211684 cub. inch	0·70055 fl. ounce	19·83638 cent. cub.
Pied cube . . .	= 1728 pouces cubes . .	1·211684 cub. foot	1·21055 cub. foot	0·03428 mèt. cub.
Voie de Paris . . .	= 56 pieds cubes . .	2·51294 cub. yards	67·79124 cub. feet	1·91953 ,,
Toise cube . . .	= 216 ,, . . .	9·692755 ,,	261·481 ,,	7·4039 ,,
Pot or quart . . .	= 2 pintes . . .	1·6405 quart	65·78 fl. ounces	1·8626 litre
Velte . . .	= 4 pots . . .	1·6405 gallon	263·14 ,,	7·45 litres
Tierçon . . .	= 12 veltes . . .	19·6855 gallons	3·15766 cub. feet	89·41 ,,
Muid . . .	= 2 feuillettes = 3 tierçons	59·0566 ,,	9·47298 ,,	2·6822 hectol.
Queue . . .	= 3 ,, . . .	88·5849 ,,	14·20947 ,,	4·1092 ,,
Boisseau . . .	= 16 litrons . . .	2·8616 gallons	459·41 fl. ounces	13·008 litres
Minot . . .	= 3 boisseaux . .	1·0735 bushel	1·37823 cub. foot	39·025 ,,
Setier . . .	= 2 mines = 4 minots .	4·2939 bushels	5·5129 cub. feet	1·5610 hectol.
Muid de grains . .	= 12 setiers . . .	6·4408 quarters	66·154 ,,	18·7319 ,,
Gros . . .	= 72 grains . . .	59·017314 grains	135·06 mils	3·82426 grammes
Once . . .	= 8 gros . . .	1·079175 ounce	1·08048 ounce	30·59 ,,
Livre . . .	= 2 marcs = 16 onces .	1·079175 pound	17·28768 ounces	489·506 ,,
Quintal . . .	= 100 livres . . .	0·96355 cwt.	1·72877 ft.-weight	48·95 kilog.
Charge . . .	= 3 quintaux . . .	2·89065 ,,	5·18631 ft.-weights	1·4685 quint.
Tonneau de mer . .	= 20 quintaux . . .	0·96355 ton	34·57536 ,,	0·97901 millier

N.B. The old French measures would fill several volumes: the land measures being excessively numerous.

THE OLD AMSTERDAM MEASURES. *Before* 1817.

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Duim	= 4 vierendeel = 8 achtendeel	1·013512 inch	0·08444 foot	25·74 millim.
Voet	= 3 palm = 11 duimen	0·929086 foot	0·92882 ,,	283·1 ,,
El	= 16 talien	2·257243 feet	2·25660 feet	687·8 ,,
Vaam	= 6 voeten	1·858172 yard	5·57294 ,,	1·6986 mètre
Roede	= 13 voeten	4·026030 yards	1·20750 rod	3·6084 mètres
League	= 20000 voeten	3·519335 miles	1·85765 league	5·6621 kilom.
Sea-league (of 20 to 1°)		3·453822 ,,	1·82310 ,,	5·5567 ,,
Vierkante voet	= 121 vierk. duimen	0·863241 sq. foot	0·86275 sq. foot	8·0149 déc. carr.
Vierkante roed	= 169 vierk. voeten	16·20976 sq. yards	1·45805 sq. rod	13·5452 mèt. carr.
Juchart	= 300 vierk. roede	1·004739 acre	4·37415 sq. chains	40·6357 ares
Morgen	= 2 juchart	2·009477 acres	8·74829 ,,	81·2714 ,,
Kubieke duim		1·041276 cub. inch	0·60208 fl. ounce	17·0479 cent. cub.
Kub eke voet	= 1331 kubieke duimen.	0·802047 cub. foot	0·80137 cub. foot	22·6908 déc. cub.
Stoop	= 2 mengeln = 4 pinten = 16 mutsjes	2·1358 quarts	85·64 fl. ounces	2·425 litres
Steekkan	= 4 viertel = 8 stoopen (40 lbs. of oil ?)	4·2715 gallons	685·15 ,,	19·40 ,,
Aam	= 4 anker = 8 steekkannen	34·172 ,,	5·4812 cub. feet	1·5520 hectol.
Vat	= 6 amen	205·032 ,,	32·8872 ,,	9·312 ,,
Vierdevat	= 8 koppen	1·4873 gallon	0·2361 cub. foot	6·755 litres
Schepel	= 4 vierdevat = 32 koppen	5·9493 gallons	0·9543 ,,	27·02 ,,
Zac	= 3 schepeln	2·2310 bushels	2·8628 cub. feet	81·06 ,,
Mudde	= 4 ,,	2·9747 ,,	3·8172 ,,	1·0809 hectol.
Grain last	= 36 zac = 27 mudden (4000 lbs. of rye)	10·0394 quarters	103·0608 ,,	29·18 ,,
Pond	= 16 ons = 32 looden = 128 drachm = 10280 as	1·089281 pound	17·451 ounces	494·09 grammes
Troy pond	= 2 mark = 16 ons = 320 engeln = 10240 as	1·085026 ,,	17·382 ,,	492·16 ,,
Steen	= 8 pond	8·714250 pounds	139·58 ,,	3·9527 kilog.
Centenaar	= 100 ,,	0·972573 cwt.	1·7451 ft.-weight	49·409 ,,
Last of heavy goods	= 4000 ,,	1·945145 ton	69·804 ft.-weights	1·97636 millier

THE OLD BRUSSELS MEASURES.

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Duim	= 4 kwart = 8 achtendeel	0·987234 inch	0·08225 foot	25·07 millim.
Voet	= 11 duimen	0·904965 foot	0·90471 ,,	275·75 ,,
El	= 16 talien	2·282972 feet	2·28233 feet	695·64 ,,
Roed	= $16\frac{1}{3}$ voeten	4·927030 yards	1·47769 rod	4·50392 mètres
Roed or verge	= 20 ,,	18·099294 feet	1·80952 ,,	5·5150 ,,
Uer	= 1000 roede or verges (or 20·15 to 1°)	3·427904 miles	1·80942 league	5·5150 kilom.
Vierkante voet	= 121 vierkante duimen	0·818963 sq. foot	0·81850 sq. foot	7·60381 déc. carr.
Vierkante roed	= $266\frac{7}{9}$ vierkante voeten	24·27569 sq. yards	2·18357 sq. rods	20·28527 mèt. carr.
Dagwand	= 100 vierkante roede	2·006255 roods	2·18357 sq. chains	20·28527 ares
Bunder	= 4 dagwand	2·006255 acres	8·73428 ,,	81·1411 ,,
Kubieke duim		0·962194 cub. inch	0·55635 fl. ounce	15·75319 cent. cub.
Kubieke voet	= 1331 kubieke duimen	0·741133 cub. foot	0·74050 cub. foot	20·96750 déc. cub.
Wine pot	= 2 pints = 4 uperken = 64 onsen	1·1928 quart	47·8328 fl. ounces	1·3544 litre
Gelte or lot	= 2 wine pots = 3 gemet	2·3857 quarts	95·6656 ,,	2·7088 litres
Stoop	= 2 beer pots = 4 beer pints = 32 glazen	2·2902 ,,	91·8372 ,,	2·6004 ,,
Aem	= 24 schreef = 48 geltes = 50 stoopen = 100 beer pots	28·6278 gallons	4·5919 cub. feet	1·3002 hectol.
Picotin	= $1\frac{1}{8}$ lots = $1\frac{1}{4}$ molevat = $4\frac{1}{2}$ pots (walloon)	2·6840 quarts	107·63 fl. ounces	3·047 litres
Viertel	= 2 half-viertel = 4 picotin	2·6840 gallons	430·51 ,,	12·19 ,,
Rasière	= 2 halsters = 4 vierteln	1·3420 bushel	1·72204 cub. foot	48·76 ,,
Muid	= 6 rasières	1·0065 quarter	10·33222 cub. feet	2·9255 hectol.
Shop pound	= 4 quarterons = 16 onsen = 64 satins = 128 gros = 9216 gr.	1·031101 pound	17·22037 ounces	467·7 grammes
Troy pound	= 2 mark = 16 onsen = 320 esterlins = 1280 felines = 10240 as	1·085026 ,,	17·38130 ,,	492·16 ,,
Steen	= 8 pond	8·248810 pounds	137·763 ,,	3·7416 kilog.
Centenaar	= 100 pond	0·920626 cwt.	1·7220 ft.-weight	46·77 ,,
Poose (coal)	= 144 ponden	1·48469 cwt.	2·4797 ft.-weights	0·67349 quint.

N.B. The land measures, roed and bunder, of the Netherlands varied in value in almost every district and parish.

THE OLD FLORENTINE MEASURES.

		Eng. Commercial Equiv.		Eng. Scientific Equiv.		French Equivalent.	
Palmo	= 6 crazie = 10 soldi	11·491656	inches	0·95737	foot	0·2918	mètre
Braccio	= 2 palmi	1·915276	foot	1·91473	,,	0·5836	,,
Passetto	= 2 bracci	1·276851	yard	2·82947	feet	1·1672	,,
Passo	= 3 ,,	1·915276	,,	5·74420	,,	1·7508	,,
Canna	= 4 ,,	2·553701	yards	7·65893	,,	2·2344	mètres
Pertica	= 5 ,, = 10 palmi	3·192130	,,	9·57366	,,	2·9180	,,
Cavezzo	= 6 ,,	3·830552	,,	1·148840	rod	3·5016	,,
Miglio	= $566\frac{2}{3}$ pertiche	1·02775	mile	0·54250	league	1·6535	kilom.
Palmo quadrato	= 100 soldi quadrati	0·916804	sq. foot	0·91655	sq. foot	8·414724	déc. carr.
Braccio quadrato	= 4 palmi quadrati	3·667216	sq. feet	3·66619	sq. feet	0·340589	mèt. carr.
Pertica quadrata	= 100 ,,	10·18971	sq. yards	91·6548	,,	8·514724	,,
Stajolo	= 66 pertiche quadrati	0·555801	rood	60·4924	sq. rods	5·61972	ares
Saccata	= 10 stajoli	1·389503	acre	6·0492	sq. chains	56·1972	,,
Palmo cubico	= 1000 soldi cubichi	0·877322	cub. foot	0·87657	cub. foot	24·82043	déc. cub.
Wine: mezzetta	= 2 quartucci	1·00358	pint	20·1216	fl. ounces	0·5697	litre
Wine: fiasco	= 2 boccale = 4 mezzette	2·00716	quarts	80·4865	,,	2·279	litres
Wine: barile	= 20 fiaschi ($133\frac{1}{3}$ pounds)	10·0358	gallons	1·6097	cub. foot	45·58	,,
Oil: mezzetta	= 2 quartucci	0·9199	pint	18·444	fl. ounces	0·522	litre
Oil: fiasco	= 2 boccali = 4 mezzette	1·8399	quart	73·776	,,	2·089	litres
Oil: barile or orchio	= 16 fiaschi (120 pounds)	7·3595	gallons	1·1805	cub. foot	33·43	,,
Oil: soma	= orcie	14·719	,,	2·3609	cub. feet	66·85	,,
Grain: mezzetta	= 2 quartucci = 4 bussoli	1·3409	pint	26·885	fl. ounces	0·761	litre
Grain: quarto	= 4 metadelle = 8 mezzette	1·3409	gallon	215·078	,,	6·091	litres
Grain: stajo	= 2 mine = 4 quarti (50 lbs. of rye)	5·3636	gallons	0·86031	cub. foot	24·36	,,
Grain: sacco	= 3 staja	2·0113	bushels	2·58094	cub. feet	73·08	,,
Grain: tonnellata	= 20 sacchi = $2\frac{1}{2}$ moggi	5·0259	quarters	51·6187	,,	14·62	hectol.
Dramma	= 3 denari = 24 grani	54·584	grains	124·914	mils	3·537	grammes
Libbra uniforma	= 12 oncie = 96 drammi	0·7486	pound	11·9918	ounces	339·55	,,
Centinajo (of 1836)	= 100 libbre	74·858	pounds	1·19918	ft.-weight	33·95	kilog.
Cantaro	= 150 libbre	1·00256	cwt.	1·79876	,,	50·93	,,
Migliajo	= 10 centinaji	10·0256	,,	11·99175	ft.-weights	339·5	,,

THE OLD VENETIAN MEASURES.[1] *Still used in the Levant.*

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Piede (old value 347·74 mm.)	1·140108 foot	1·13978 foot	347·4 millim.
Braccio, for silken fabrics	2·096105 feet	2·09551 feet	638·7 ,,
,, woollen fabrics	2·242803 ,,	2·24217 ,,	683·4 ,,
Chebbo = 4½ piede	1·710162 yard	5·12903 ,,	1·5648 mètre
Passo = 5 ,,	5·700439 feet	5·69892 ,,	1·7387 ,,
Pertica or cavezzo = 6 piede	2·280216 yards	6·83871 ,,	2·0864 mètres
Miglio = 1000 passi	1·080706 mile	0·68387 league	1·7387 kilom.
Piede quadrato	1·299848 sq. foot	1·29911 sq. foot	12·06868 déc. carr.
Chebbo quadrato = 20¼ piedi quadrati	2·924658 sq. yards	26·30949 sq. feet	2·4439 mèt. carr.
Passo quadrato = 25 ,,	3·6107 ,,	32·47778 ,,	3·01717 ,,
Tavola or cavezza quadrato = 36 piedi quadrati	5·1994 ,,	46·76800 ,,	4·3447 ,,
Campo = 640 tavole	2·7501 roods	2·99315 sq. chains	27·8062 ares
Migliajo = 1000 passi quadrati	2·9840 ,,	3·24778 ,,	30·1717 ,,
Piede cubico	1·481972 cub. foot	1·48070 cub. foot	41·92658 déc. cub.
Wine: bozza = 2⅔ boccale = 4 quartucci	2·3780 quarts	95·35 fl. ounces	2·70 litres
Wine: conchia or mastello = 6 secchi = 24 bozze	14·2678 gallons	2·28851 cub. feet	64·80 ,,
Wine: anfora = 4 biconcie = 8 mastelli	114·1421 ,,	18·30811 ,,	5·184 hectol.
Oil: miro = 30½ lbs. of oil, p. gr.	3·3765 gallons	0·54079 cub. foot	15·312 litres
Oil: migliajo = 40 miri = 1210 ,, ,,	135·060 ,,	21·63140 cub. feet	6·125 hectol.
Grain: quarto = 4 quartaroli = 33 lbs. of wheat, p. gr.	4·5860 gallons	0·73558 cub. foot	20·828 litres
Grain: staro = 4 quarti	2·2930 bushels	2·94231 cub. feet	83·312 ,,
Grain: moggio = 4 stari	1·1465 quarter	11·76925 ,,	3·3325 hectol.
Sazio peso sottile = 24 carati	64·58438 grains	147·79 mils	4·185 grammes
Libbra ,, = 12 oncie = 6912 grani	0·66425 pound	10·64088 ounces	0·3013 kilog.
Centinajo peso sottile = 100 libbra peso sottile	66·42524 pounds	1·06409 ft.-weight	30·13 ,,
Carica = 4 centinaji peso sottile	2·3723 cwt.	4·2564 ft.-weights	1·2052 quint.
Sazio peso grosso = 32 carati	96·69910 grains	233·997 mils	6·626 grammes
Libbra ,, = 12 oncie = 9216 grani	1·05171 pound	16·84777 ounces	0·4771 kilog.
Centinajo ,, = 100 libbre	105·17145 pounds	1·68477 ft.-weight	47·71 ,,
Migliajo = 10 centinajo	9·39031 cwt.	16·84777 ft.-weights	477·05 ,,

[1] For other old Italian measures see tables in Part I. giving separate units.

METRIC COMMERCIAL SYSTEMS,

OR

SYSTEMS BASED ON THE FRENCH METRE.

N.B.—The units in these systems are employed in commerce at any temperature, without reduction for expansion. The standard temperature is 0° centigrade in vacuo.

No. I. THE PRESENT

Used in France as a Commercial System since 1840.

Units.	Multiples.		Eng. Commercial Equiv.
Millimètre . .	0·001	mètre .	0·039 382 inch .
Centimètre . .	0·01	„ .	0·393 820 „ .
Décimètre . .	0·1	„ .	0·328 183 foot .
Mètre . .	1	. . .	1·093 943 yard .
Décamètre . .	10	mètres .	1·988 987 pole .
Hectomètre .	100	„ .	0·497 248 furlong .
Kilomètre . .	1000	„ .	0·621 560 mile .
Centimètre carré.	0·0001	mètre carré	0·155 094 sq. inch .
Décimètre carré .	0·01	„	0·107 704 sq. foot .
Mètre carré .	1	. . .	1·196 716 sq. yard .
Are. . .	100	mèt. carrés	0·098 902 rood .
Hectare . .	100	ares . .	2·472 550 acres .
Kilomètre carré .	100	hectares .	0·386 336 sq. mile .
Centimètre cube .	0·001	litre . .	0·061 079 cub. inch
Decimètre cube or litre .	1	. .	0·220 180 gallon .
Hectolitre . .	100	litres. .	2·752 250 bushels .
Mètre cube or stère .	1000	„ . .	1·309 140 cub. yard
Milligramme .	0·001	gramme .	0·015 432 grain .
Gramme . .	1	. . .	15·432 349 grains .
Kilogramme .	1000	grammes .	2·204 621 pounds .
Quintal . .	100	kilogrammes	1·968 412 cwt. .
Millier or tonne .	1000	„	0·984 206 ton .

Metric units are arranged at 0° Centigrade in vacuo both for English Commercial Units are at 62° Fahr. in air, bar. 30 inches, English Scientific Units are arranged at 0° Centigrade in vacuo,

N.B. Some of the nominal metric units, being mere terms for

FRENCH METRIC SYSTEM.

Also adopted by other nations at various dates. See text.

Eng. Scientific Equiv.	Dutch term.	Italian term.	Greek.
0·032 809 tithe .	Streep. . .	Atoma . .	Gramme
0·328 090 „ .	Duim . . .	Dito . . .	Dactylus
3·280 899 tithes .	Palm . . .	Palmo . .	Palame
3·280 899 feet .	El . . .	Braccio . .	Pecheus
3·280 899 rods .	Roed . . .	. . . . .	
3·280 899 chains .	. . . .	. . . . .	
0·328 090 league .	Myl . . .	Chilometro .	Stadion
0·107 643 sq. tithe .	Vierkante duim .	Dito quadrato .	
10·764 299 sq. tithes.	„ palm .	Palmo quadrato .	
10·764 299 sq. feet .	„ el .	Metro quadrato .	
10·764 299 sq. rods .	„ roed .	Tavola . .	Strema
10·764 299 sq. chains	Bunder . .	Ettaro, Tornatura	
0·107 643 sq. league	Vierkante myl .	Chilom. quad. .	
35·316 581 fluid mils	Kubieke duim .	Dito cubico .	Kybos
35·316 581 fluid oz. .	Kop or kan. .	Pinta . . .	Litra
3·531 658 cubic feet	Mudde or vat .	Soma. .	Koilon
35·316 581 ,,	Kubieke el, Wisse	Metro cubico .	
35·316 581 doits .	Milligram . .	. . . . .	
35·316 581 mils .	Wigtje. . .	Denaro . .	Drachme
35·316 581 ounces .	Pond . . .	Libbra . .	Mna
3·531 658 ft.-weights	Centenaar . .	Centinajo . .	Talanton
35·316 581 ,,	Ton . . .	Migliajo . .	Tonos

commerce and for scientific purposes. (See Part II., Chapter VI.)
at mean sea level. See pp. 282, 283.
for technical and scientific purposes. (See Part II., Chapter VI.)
decimal multiples, are omitted in the commercial system.

Conversion Tables for reducing Metric Measures

Units	Decimètres into inches.	Mètres into feet.	Mètres into yards.
1	3·9382	3·28183	1·09394
2	7·8764	6·56366	2·18789
3	11·8146	9·84549	3·28183
4	15·7528	13·12732	4·37577
5	19·6910	16·40915	5·46972
6	23·6292	19·69098	6·56366
7	27·5674	22·97281	7·65760
8	31·5056	26·25464	8·75155
9	35·4438	29·53647	9·84549
10	39·3820	32·81830	10·93943

	Décim. car. into sq. in.	Mèt. car. into sq. ft.	Mèt. car. into sq. yards.
1	15·5094	10·7704	1·19672
2	31·0188	21·5409	2·39343
3	46·5283	32·3113	3·59015
4	62·0377	43·0817	4·78686
5	77·5471	53·8522	5·98358
6	93·0565	64·6226	7·18030
7	108·5659	75·3930	8·37701
8	124·0754	86·1634	9·57373
9	139·5848	96·9339	10·77045
10	155·0942	107·7043	11·96716

	Litres into cubic inches.	Litres into cubic feet.	Litres into gallons.
1	61·0793	0·035 347	0·22018
2	122·1587	0·070 694	0·44036
3	183·2380	0·106 041	0·66054
4	244·3173	0·141 388	0·88072
5	305·3966	0·176 739	1·10090
6	366·4759	0·212 082	1·32108
7	427·5553	0·247 429	1·54126
8	488·6346	0·282 776	1·76144
9	549·7139	0·318 123	1·98162
10	610·7933	0·353 468	2·20180

into English Commercial Measures.

Units	Kilomètres into miles.	Grammes into grains.	Kilogrammes into oz.
1	0·62156	15·432 349	35·273 941
2	1·24312	30·864 698	70·547 882
3	1·86468	46·297 047	105·821 823
4	2·48624	61·729 396	141·095 764
5	3·10780	77·161 745	176·369 704
6	3·72936	92·594 094	211·643 646
7	4·35092	108·026 443	246·917 587
8	4·97248	123·458 792	282·191 528
9	5·59404	138·891 141	317·465 469
10	6·21560	154·323 487	352·739 408

	Kilomètres carrés into sq. miles.	Hectares into acres.	Kilogrammes into lbs.
1	0·38634	2·47255	2·204 621
2	0·77267	4·94510	4·409 242
3	1·15901	7·41765	6·613 864
4	1·54534	9·89020	8·818 485
5	1·93168	12·36275	11·023 107
6	2·31802	14·83530	13·227 728
7	2·70435	17·30785	15·432 349
8	3·09069	19·78040	17·636 970
9	3·47702	22·25295	19·841 592
10	3·86336	24·72550	22·046 213

	Hectolitres into bushels.	Quintals into cwt.	Milliers into tons.
1	2·75225	1·968 412	0·984 206
2	5·50450	3·936 824	1·968 412
3	8·25675	5·905 236	2·952 618
4	11·00900	7·873 648	3·936 824
5	13·76125	9·842 060	4·921 030
6	16·51350	11·810 472	5·905 236
7	19·26575	13·778 884	6·889 442
8	22·01800	15·747 296	7·873 648
9	24·77025	17·715 708	8·857 854
10	27·52250	19·684 120	9·842 060

METRIC SYSTEMS.

NO. 2. *The French Mesures usuelles used in France from* 1812 *to* 1840, *also adopted in Rhenish Bavaria.*

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Pouce	= 12 lignes.	1·09394 inch	0·91136 tithe	27·777 millim.
Pied	= 12 pouces	1·09394 foot	1·09363 foot	333·333 ,,
Aune	= 3·6 pieds	1·31273 yard	3·93708 feet	1200 ,,
Toise	= 6 pieds	6·56366 feet	6·56180 ,,	2 mètres
Perche	= 5 toises	10·93943 yards	3·28090 rods	10 ,,
Mille	= 500 ,,	0·62156 mile	0·32809 league	1 kilom.
Pied carré	= 144 pouces carrées	1·19671 sq. foot	1·19670 sq. foot	11·1111 déc. carr.
Toise carrée	= 36 pieds carrés	4·78686 sq. yards	43·05720 sq. feet	4 mèt. carr.
Perche	= 25 toises carrées	119·67160 ,,	10·76430 sq. rods	1 are
Hectare	= 100 perches carrées	2·47255 acres	10·76430 sq. chains	1 hectare
Pouce cube		1·30914 cub. inch	0·75696 fl. ounce	21·431 cent. cub.
Pied cube	= 1728 pouces cubes	1·30914 cub. foot	1·30802 cub. foot	37·037 déc. cub.
Toise cube	= 216 pieds cubes = 8000 litres	16·47312 cub. yards	282·5326 cub. feet	8 mèt. cub.
Quart		1·76144 gill	8·829 fl. ounces	0·25 litre
Litre	= 4 quarts $= \frac{1}{8000}$ toise cube	1·76144 pint	35·317 fl. ounces	1 ,,
Velte	= 10 litres $= \frac{1}{800}$,,	2·20180 gallons	0·35317 cub. foot	10 litres
Tonne de bière	= 7½ veltes $= \frac{3}{320}$,,	16·5135 ,,	2·64874 cub. feet	75 ,,
Litre	$= \frac{1}{8000}$,,	1·76144 pint	35·317 fl. ounces	1 litre
Boisseau	= 12½ litres $= \frac{1}{640}$,,	2·75225 gallons	0·44146 cub. foot	12·50 litres
Setier	= 8 boisseaux $= \frac{1}{80}$,,	2·75225 bushels	3·53166 cub. feet	1 hectol.
Muid	= 10 setiers $= \frac{1}{8}$,,	27·5225 ,,	35·31658 ,,	10 ,,
Tonneau de grain	= 1½ muid $= \frac{3}{16}$,,	41·28375 ,,	52·97487 ,,	15 ,,
Grain		0·837205 grain	1·916 mil	0·05425 gramme
Gros	= 72 grains	0·137776 ounce	137·9554 mils	3·90625 grammes
Once	= 8 gros	1·102311 ,,	1·10364 ounce	31·25 ,,
Livre	= 16 onces	1·102311 pound	17·65829 ounces	0·5 kilog.
Quintal	= 200 livres	1·968412 cwt.	3·53166 ft.-weights	100 ,,
Tonneau	= 10 quintaux	0·984206 ton	35·31658 ,,	1000 ,,

The once was also valued at 32 grammes for medicinal purposes, according to the Codex.

METRIC SYSTEMS.

No. 3. *The Baden System, used since* 1810.

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Zoll	1·18146 inch	0·98427 tithe	30 millim.
Fuss . . = 10 zoll	0·98455 foot	0·98427 foot	300 ,,
Elle . . = 2 feet	1·96910 ,,	1·96854 ,,	600 ,,
Ruthe . = 10 feet	3·28183 yards	0·98427 rod	3 mètres
Stunde, 25 to 1°	2·76305 miles	1·45848 league	4·4454 kilom.
Meil . . = 2 stunden	5·52610 ,,	2·91695 leagues	8·8907 ,,
Quadratfuss = 100 quadratzoll	0·969339 sq. foot	0·96879 sq. foot	9 déc. carré
Quadratruthe = 100 quadratfuss	10·77045 sq. yards	0·96879 sq. rod	9 mèt. carr.
Morgen . = 400 quadratruthen . . .	0·890118 acre	3·87515 sq. chains	36 ares
Quadrat-meil	30·53775 sq. miles	8·50859 sq. leagues	79·0445 kil. car.
Kubikzoll	1·64914 cub. inch	0·95355 fl. ounce	27 cent. cub.
Kubikfuss . = 1000 kubikzoll	0·95437 cub. foot	0·95355 cub. foot	27 déc. cub.
Holz-klafter = 144 kubikfuss	5·08994 cub. yards	137·3107 cub. feet	3·888 mèt. cub.
Kubikruthe = 1000 kubikfuss	35·3468 ,,	0·95355 cub. rod	27 ,,
Glas or becher = $5\frac{5}{9}$ kubikzoll	1·05686 gill	5·2975 fl. ounces	0·15 litre
Mass or mässl = 10 glas = $55\frac{5}{9}$ kubikzoll .	2·64216 pints	52·975 ,,	1·5 ,,
Stutze or sester = 10 mass = $555\frac{5}{9}$,, .	3·3027 gallons	0·52975 cub. foot	15·0 litres
Ahm or malter = 10 stützen = $5555\frac{5}{9}$,, .	4·128375 bushels	5·29749 cub. feet	1·50 hectol.
Fuder or zuber = 10 ahm = $5555\frac{5}{9}$,, .	41·28375 ,,	52·97487 ,,	15 ,,
Pfennig . = 10 ass	7·716175 grains	17·658 mils	0·5 gramme
Centass . = 10 pfennige	77·161745 ,,	0·17658 ounce	5 grammes
Zehnling . = 10 centass	1·763697 ounce	1·76583 ,,	50 ,,
Pfund . = 10 zehnling	1·102311 pound	17·65829 ounces	500 ,,
Stein . = 10 pfund	11·023107 pounds	0·17658 ft.-weight	5 kilog.
Centner . = 10 stein	0·984206 cwt.	1·76583 ,,	50 ,,

Y 2

METRIC SYSTEMS,

No. 4. *The Hessian System, used since* 1818.

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Zoll		0·984548 inch	0·82022 tithe	25 millim.
Fuss	= 10 zoll	0·820457 foot	0·82022 foot	250 ,,
Elle	= 24 ,,	1·969098 ,,	1·96854 ,,	600 ,,
Ruthe or klafter	= 10 fuss	8·204575 feet	8·20225 feet	2·5 mètres
Kilometer	= 400 ruthen	0·621560 mile	0·32809 league	1 kilom.
Quadratfuss	= 100 quadratzoll	0·67315 sq. foot	0·67277 sq. foot	6·25 déc. carr.
Quadratruthe	= 100 quadratfuss	7·47948 sq. yards	0·67277 sq. rod	6·25 mèt. carr.
Morgen	= 400 quadratruthe	2·47255 roods	2·69107 sq. chains	25 ares
Hectar	= 4 morgen	2·47255 acres	10·76430 ,,	1 hectare
Kubikzoll		0·95436 cub. inch	0·55182 fl. ounce	15·625 cent. cub.
Kubikfuss	= 1000 kubikzoll	0·55229 cub. foot	0·55182 cub. foot	15·625 déc. cub.
Stecken	= 100 kubikfuss	55·2294 cub. feet	55·182 cub. feet	1·5625 mèt. cub.
Kubikklafter	= 1000 ,,	20·45534 cub. yards	0·55182 cub. rod	15·625 ,,
Schoppen or mässchen	= 32 kubikzoll	3·52288 gills	17·65829 fl. ounces	0·5 litre
Mass or geschied	= 4 schoppen = 128 kubikzoll	1·76144 quart	70·63316 ,,	2·0 litres
Viertel or kümpfe	= 4 mass = 512 kubikzoll	1·76144 gallon	282·5326 fl. ounces	8·0 ,,
Simmer	= 4 kümpfen = 2·048 kubikfuss	7·04576 gallons	1·13013 cub. foot	32 ,,
Malter	= 4 simmer = 8·192 kubikfuss	3·52288 bushels	4·52052 cub. feet	1·28 hectol.
Ahm	= 20 viertel = 10·240 kubikfuss	35·2288 gallons	5·65065 ,,	1·60 ,,
Fuder	= 6 ahm = 61·44 kubikfuss	211·3728 gallons	33·9039 ,,	9·6 ,,
Richtpfennig		15·069689 grains	34·4888 mils	0·9765 gramme
Quentchen	= 4 richtpfennige	0·137776 ounce	137·9554 ,,	3·906 grammes
Loth	= 4 quentchen	0·551155 ,,	0·55182 ounce	15·625 ,,
Pfund	= 32 loth	1·102311 pound	17·65829 ,,	500 ,,
Centner	= 100 pfund	0·984206 cwt.	1·76583 ft.-weight	50 kilog.

METRIC SYSTEMS.

No. 5. *The Swiss System, used in Canton Waadt since 1822.*

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Zoll	1·28146 inch	0·98427 tithe	30 millim.
Fuss = 10 zoll	0·98455 foot	0·98427 foot	300 ,,
Elle = 2 fuss	1·96910 ,,	1·96854 ,,	600 ,,
Stab = 4 ,,	1·31273 yard	3·93708 feet	1·2 mètre
Ruthe or toise = 10 ,,	3·28183 yards	0·98427 rod	3 mètres
Kilometer = 333⅓ ruthen	0·62156 mile	0·32809 league	1 kilom.
Stunde = 1600 ruthen	2·98349 ,,	1·57483 ,,	4·8 ,,
Old Swiss meil, 13·3 to 1°	5·19369 miles	2·74149 leagues	8·3559 ,,
Quadratfuss = 100 quadratzoll	0·96934 sq. foot	0·96879 sq. foot	9 déc. carr.
Quadratruthe = 100 quadratfuss	10·77045 sq. yards	0·96879 sq. rod	9 mèt. carr.
Fossorier = 50 quadratruthe	0·44506 rood	48·43935 sq. rods	4·5 ares
Jauchart or pose = 500 quadratruthe	1·11265 acre	4·84394 sq. chains	45 ,,
Quadratkilometer	0·38634 sq. miles	0·10764 sq. league	1 kilom. car.
Kubikfuss = 1000 kubikzoll	0·95437 cubic foot	0·95355 cub. foot	27 déc. cub.
Kubiktoise = 1000 kubikfuss	35·3468 cub. yards	0·95355 cub. rod	27 mèt. cub.
Moule = 125 ,,	4·41835 ,,	119·193 cub. feet	3·375 ,,
Glas, becherlein or copet = 5 kubikzoll	0·95118 gill	4·7677 fl. ounces	0·135 litre
Pot, mass, or mine = 10 glas or copet = 50 kubikzoll	2·37795 pints	47·6774 ,,	1·350 ,,
Broc or gelte = 10 pot or emines = 500 ,,	2·97243 gallons	0·47677 cub. foot	13·500 litres
Eimer or setier = 3 brocs = 1·5 kubikfuss	8·91729 ,,	1·43032 ,,	40·5 ,,
Fuder or char = 16 eimer = 24·0 ,,	17·83458 bushels	22·88514 cub. feet	6·480 hectol.
Sac = {10 geltes or quarteron = 5 kubikfuss}	3·71554 ,,	4·76774 ,,	1·350 ,,
Muid = 10 sacs = 50 kubikfuss	37·15538 ,,	47·67738 ,,	13·50 ,,
Gran	0·837205 grain	1·9161 mil	0·05425 gramme
Pfennig = 18 grans	15·069689 grains	34·4888 mils	0·9765 ,,
Quentchen = 4 pfennige	0·137776 ounce	137·9554 ,,	3·906 grammes
Unze = 8 quentchen	1·102311 ,,	1·10364 ounces	31·25 ,,
Pfund = 16 unze	1·102311 pound	17·65829 ounces	0·500 kilog.
Centner = 100 pfund	0·984206 cwt.	1·76583 ft.-weight	50 ,,

CHAPTER III.

COLLECTIONS OF ORIENTAL MEASURES.

THE Oriental measures in the following tables differ from the systematised measures of European nations and provinces principally in the very important consideration that they are not national systems. The measures are not identical throughout a kingdom or a province, but vary in different towns and different parts of the same province ; and to collections of such measures the word system would not be applicable.

It will, however, be noticed that there is a general resemblance throughout the whole of the measures given under the heads of

1. Turkish measures.
2. Greek measures.
3. Syrian measures.
4. Arab measures.
5. Egyptian measures.
6. Abyssinian measures.
7. Berber, Tunisian, and Moorish measures.
8. Algerine measures.
9. Persian measures.
10. North - Indian measures.

In fact, they appear to form detached parts and modifications of one general system or ruling intention, although the variety in value of the units may be occasionally rather large. This similarity is entirely due to the Moslem predominance that has existed and continued over the whole of those countries for a lengthened period, and it is on account of this evident self-classifi-

cation that the group of Moslem or Oriental collections of measures is treated apart.

The three grand divisions under which nations and races can be classified are, Christian, Moslem, and Pagan ; their metrical systems also group most conveniently in the same way. Modern Christianity is by association or through transition European, as it barely exists in Asia and Africa ; in the same way Islam is Oriental, and Orientalism is confined to parts of Asia and Africa ; while paganism covers the remainder of the world unpeopled from Europe. Orientalism, forming the intermediate group, hence requires special notice in the sense here applied. It hardly admits of exact definition beyond that it includes races still under Moslem influence ; as it does not by any means include all races of Oriental origin. The Hungarian is an Asiatic and nearly a Turkish race by descent. The modern Russian, offspring from the blending of ancient Russian and of Slavonic races under Rurik, and only partially Finnish or Ugrian, is an undoubted Oriental by descent ; for the ancient Russian was a Scythian-Tatar, whose original location was near Mount Taurus, and the Slavonian before his original settlement on the Danube was a Semi-Persian : the ancient Portuguese were probably Phœnician, and some of the Italian peoples descendants of Lycians and emigrants from Asia Minor : yet none of these nations can now be justly termed Oriental. The term Orientalism cannot either be confined or applied exclusively to races or countries that never fell under the yoke of Roman Imperialism, and hence retained their own measures ; for the reason that all the countries mentioned in the above list were subjugated, and submitted to the political domination of Rome, which was then considered

conterminous with civilisation. The distinctive limit is mostly coincident with that of religious belief, although original Christianity spread itself over Eastern nations; hence the origin of the present limit between Christendom and Islam, that is so marked in its bearing on Metrical Systems, requires some explanation.[1]

[1] Original Christianity, spreading under missionary and apostolic teaching, extended to the two extremes of Britain and Southern India; idolatry and paganism gave way before it, and Christian life and doctrine were accepted: but Christian dogma did not exist; in fact, Christianity was actually Arian for nearly five centuries throughout the greater part of the world, both east and west; the vagueness in detail of the Christian tenets rendering them acceptable to all forms of thought.

From A.D. 319 to 351, Christendom was divided against itself: the two parties, Athanasians and Arians, were hostile factions. The former evolved and enforced a ponderous amount of dogma, besides aiming at a centralised hierarchical sway, an imperialised ecclesiasticism of arrogant authority; while the latter, wishing to retain the previously existing freedom of tenet, struggled against this usurpation of supremacy or dominion over the realms of religious opinion, and were for a long time successful. As, however, they in their turn, not content with opposing Athanasianism, also fell to drawing up creeds, and confessions of faith involving dogma, and were forced into drawing up theological definitions, and visiting transgressors with excommunication; they thus ceased to remain Christians of the old type, and became rigidly sectarian, opposing the Athanasians in the main, and excommunicating both Semi-Arians and Sabellians on the one side and on the other. Athanasianism eventually triumphing at central points with the aid of papal and imperial support, set to work to secure its ecclesiastical domination, centralisation, and invariability of dogma over the whole of Christendom. In fact, a new and rigid form of Christianity was propagated from A.D. 351 till A.D. 600, when Spain was still partly Arian, and this had hardly obtained universal assent, when Mahammed reproduced a modified Arianism in the form of Islam in 604 to 623 A.D.

Islam allowed extreme diversity of tenet without interference, thus imitating early Christianity, but being severely monotheistic, was uncompromising with both pagan idolatry and Christian image-reverence. A hard and firm line thus drawn was rigidly adhered to. Association with or imitation of the infidel was henceforth impossible, even in the minutest detail of habit and custom; towns and places were renamed, and pagan and Christian units of measurement rejected or altered.

The original uncompromising separation of the Moslem from both Christian and pagan in point of religion caused a most rigid line to be made practically between Islamic and non-Islamic measures, while the geographical locality of the Moslem races also intervened between Christendom and paganism, and thus divided Christian and Roman units from pagan and miscellaneous measures.

This dividing line in some places became eventually less defined and uncertain, more especially in India and Eastern Asia, where the population became only partly Moslem ; but it exists even now.

Among the peculiarities of Islamic units and systems may be noticed, the adherence to a cubit or a double cubit as a unit of length, and the absence of a foot, a want of rigidity about surface measures or land-units, and often their entire absence ; also the general absence of all measures of capacity both wet and dry ; cubic units, and submultiples of the cubic unit, are and have been comparatively rare ; both these and capacity units being generally supplanted by direct weight-units.

In some places, a pik (cubit) and a rotal (pound), or, as we might say, a stick and a stone, answered all purposes.

These facts inform us most clearly of the habits of the peoples using such systems, whether due to race-tendency or to the effect of Islam. They indicate non-agricultural races, or tribes not much attached to tillage, rather pastoral and semi-nomadic, trusting to force rather than to definition as the preserver of boundary. They show those races to be not only abstemious as regards consumption of alcoholic liquid, but positively non-commercial, despising trade as a means of acquiring wealth,

and treating both usury and speculation as sinful. Races of this type being generally noble, brave, and religious, their habits would naturally be warlike, and their tendencies in time of peace would be to employ their energies in work involving skill and science, or, as we would say, professional, technical, operative and scientific labour. These deductions are completely borne out by the habits of the Spanish Moors, and the earlier Arabs in Egypt and Syria, and the former Indian Moguls: even the decadence of these races, the absence of all energy and scientific or skilled achievement or labour, is shown in the diminution in number of the metrical units in use, and the absence of both the very small and very large units that would occasionally enter into such work.

There is, however, one point as regards Moslem metrical units that is specially worthy of notice; and that is, that anything like rigid adherence to standard is totally absent. One would imagine that a severe rigid monotheistic dominion would, at least within certain moderate limits, enforce some uniformity of unit, or of standard; and one would naturally look to the standard units of Mekka-Sharif as prototypes. Certainly the pik of Mekka, which happened to be very nearly 2¼ English feet, and the rotal of Mekka, that is very nearly a pound avoirdupois, are treated nominally as standard units, and these units are used at several other places including Stambul; but anything approaching a wide-spread uniformity of standard is quite wanting.

The types of pik are, however, comparatively few; on examining the units of this type from the Russian arsheen to the Bushahr gezcha, pp. 57 to 59, it will be noticed that the values generally lie between 2 and 2⅓ English feet, and they are probably by derivation, sacred cubits:

while the piks of Arab origin, whether used in Arabia, Tunis, Algiers, or Morocco, are approximately 1½ English foot, and thus belong to another class, the natural cubit. The arsheens, piks, mihandesah, or halibins also form a class by themselves as land-cubits having high values. The distinction between the tradesman's small pik and large pik for two sorts of fabrics or stuffs exists in a way corresponding to that of the Italian and South European arrangement in bracci and ells.

Proceeding to larger linear units, the pace is a recognised Oriental measure, the most common type of which appears to be the pace of three Turkish or large cubits, or of four Arab or natural cubits, about six feet; but there is considerable lack of exact information about Oriental paces. The Kassaba, gasab, or rod, having been also based on diverse cubits is also very various in value, and does not admit of very exact definition; the commonest type is the gasab of 2 paces, equal to 8 small cubits, or 6 ordinary cubits, or 4 large cubits, approximately 12 English feet, but sometimes more nearly ten old Arab feet. Tracing these gasabs back to their origin, they were apparently founded on ancient cubits of three sorts, the Hashemic cubit of 0·6417 m. or about 2·15 English feet, the Beledi cubit of 0·5775 m. or about 1·90 English foot, and the later Arab cubit of 0·4813 m. or about 1·56 English foot; hence the diversity of the derived units. The same complication also occurs in the Oriental chains of 10 gasab and in the Oriental miles of nominally 1000 paces, or 500 gasab, which are sometimes considered 5000 feet, and sometimes 6000 feet of different values. Oriental paces, rods and miles, are hence speculative units. The farsakh, agasha or parasang, a league representing an hour's walk on rather bad roads of

about 3 miles, is therefore the unit more commonly referred to, and in general use as an itinerary measure; it may be nominally fixed at 3 local miles, but actually is as variable as a Scotch bittock. Apart from the above units, that are purely Oriental by origin, there are others that have survived and existed for a long time in some Oriental countries, but are probably of Pagan origin. The Arabian gaz differs from a two-foot pik merely in name, but the gaz and hadid of Mesopotania, the zar' of Persia, and the North Indian gaz are evidently yards or double natural cubits. On these as primary units, the itineraries, the Indian kos of 2000 gaz, and the Persian farsakh of 6000 zar', and the surface units, the North-Indian biggahs are evidently based.

In Oriental surface measures, there is the Arab square chain, of 100 square gasab, and the Arab feddan of 400 square gasab, the former corresponding to the English rood, the latter to the English acre; but their values, owing to the above-mentioned causes, are necessarily also variable. They are certainly adopted in Arabia, Turkey, and Egypt; but more often units of surface in Oriental countries are quite unused; it is said that there are none in Persia.

This absence of land units is notable, but due to assignable causes. The Oriental landowner or landholder is not, like the European, anxious to know how much land he holds, nor does he want others to know it; it appears to him inquisitorial interference; he has a tenderness on the subject similar to that of an English tradesman with regard to his books of account; and besides is afraid of assisting the tax-gatherer and the oppressive extortionate officials that are inseparable from Oriental and semi-Oriental sway. Again even under

a just régime of fixed tenure and just officials, he is opposed to permanent taxation ; he perfectly admits the right of the Government to demand at intervals a war-tax, or a subsidy, for some comprehensible clear object, and he fully acknowledges it is his duty to assist the State ; but a perpetual rate, and worse a rated tax, is in his eyes severe and repugnant in every way. A lump-sum demanded occasionally he cheerfully agrees to in a way strange to a North-European, but a yearly rate per acre opens to his vista of thought a possible double form of future enhancement, both by the acre and by the year; in fact, the principle is too dreadful to be admitted, otherwise than under strong compulsion. The land-units still existing in Oriental countries, that differ very markedly from the Arab feddan, are generally surviving pagan measures : the North Indian biggahs are units of that description.

Cubic measure also seems at present comparatively unknown in Oriental countries, almost all goods being estimated by weight. Capacity measures are occasionally used but generally rare ; as liquids, with the exception of oil, are not much consumed or sold as merchandise, and both liquids and grain are sold by weight. The strong objection to buying dry goods by weight, due to possible adulteration with water, does not exist in Oriental and hot countries under climates of very speedy evaporation ; and the speed and time saved by filling a vessel in preference to weighing a liquid is unimportant to people that hardly appreciate the value of time. Pseudo-capacity measures are, however, sometimes used for convenience' sake ; these holding a certain weight of commodities of different sorts are of different capacities for the same weight in accordance with the specific gravities of the

merchandise. Real capacity measures are few, being generally the most commonly used and locally prevalent pseudo-capacity measures; thus in wheat-consuming countries it would be a wheat measure, in rice growing countries a rice measure, and in millet-growing countries a millet measure, holding a fixed weight of grain of each sort. Such a measure, being that most frequently used, eventually becomes the general measure for grain of all sorts, and then is a real capacity measure, independent of weight in all subsequent application. Some of the kiloz, mecmeda, ardeb, temen, tarri and almud thus become real capacity measures, while others are not; it takes, however, much investigation to discover to which class any one of them may belong, and it has been found impossible to distinguish them in the tables of this book.

Oriental weight-units are, like most European pounds, antiquated in origin, and of irrecoverable standard; that is, they cannot be readjusted or newly formed at any time from cubic measure; for instance, the French kilogramme is the weight of a cubic decimètre of water, and the English foot-weight or talent is the weight of a cubic foot of water, but the Turkish, Egyptian, Persian and Indian, okas, rotals, wakia, and ser, do not admit of this, the sole check on them is by balancing them against a certain number of coins or pieces of money of known weight. Formerly they were recognised submultiples of talents, anciently based on the weight of water contained in cubic measures formed on then well-known linear units; but the linear units were numerous, the talents were of several kinds, and the modes of subdivision were various; thus making the derivations complicated matters of archaic research, in all but a very few cases.

The rotal generally is now the term for an Oriental unit of weight corresponding in use to a European commercial pound; while the yusdruma, cheki, saddirhem, okiejah, or wakiah is more often a smaller monetary pound corresponding to the former English Troy-pound; the oka being a larger unit than either, nearly but not exactly falling in both series, being exactly equal to four okiejah, and nearly $2\frac{1}{4}$ rotal; this is the Turkish and the present typical Oriental mode. The Syrian rotals are exceptional, being large units exceeding the oka. In most cases the wakia is an ounce of 10 or 12 dirhems, while the saddirhem or small pound of 100 dirhems is absent from the system, and replaced by some subsidiary rotal or other special unit. The Persian dirhem is exceptional and has a high value, being about half an ounce. The miskal, mitkal, or kaffala is the primary unit most frequently used from Persia to Morocco; its value is almost invariable, nearly 72 grains English, or one-sixth of an ounce. The foregoing units are the basic units of weight, some of them occurring and some being absent from each system. The principal difficulty in comprehending the systems lies with the waki', wakiah, or okiejah, for sometimes and more generally the wakiah is an ounce, as in Arabia, Egypt, Tripoli, Tunis, and Morocco; while the okiejah in Turkey and the waki' in Persia are small pounds. The clue to clearness in such doubtful cases is to treat all Oriental units of weight generally either as multiples of some miskal, or of some dirhem, up to some approximate pound, and then to start again from the derived units, going up to some approximate kanthar or hundredweight.

Among the peculiarities of Oriental systems of weight units, there is one that partly extends into Pagan systems.

The *man*, pronounced *mun*, and sometimes called by the English *maund*, is a very variable unit which does not occur in European or Eastern Asiatic systems. It does, however, exist in Southern India, although not as a practically important unit, for the kandi is more frequently used. The man is a term applied to units of three sorts,

1. A very small *man*, between 2 and 14 lbs.
2. The kachcha man, of about 28 to 40 lbs.
3. The large man, of 70 to 80 lbs.

Probably the whole of these are by origin *stones*, although the smallest, those of the first class, alone approach the English stones in value, while those of the second are approximate quarters, and those of the third being about three-quarters of a hundredweight may be termed approximate hundredweights. Class 1 is peculiar to Arabia, Syria, Turkey and Persia ; class 2 is peculiar to Southern and Central India ; while class 3 exists throughout the whole of Northern India, and in the special form of the *man-i-hāsham* in Persia also.

The second class thus exists beyond the strict geographical limits assigned to purely Oriental systems, although probably due to Oriental influence in some now unassignable manner.

Proceeding to the Oriental hundredweight or *kanthar*, it will be observed that this is in most cases 100 rotal, an arrangement followed by most European nations and derived from the Arabs ; the exceptional kanthars are very rare.

Units above the kanthar are very few ; the bahar of Arabia is a load very varying in value, between $1\frac{1}{2}$ and

7 hundredweight; the kharwar of Persia is also a large load; the kāṛa of Persia, a large unit of about $5\frac{1}{2}$ tons, and the sauman of Northern India, of $3\frac{1}{2}$ tons, are both equal to 100 large man.

On the whole the Oriental arrangement of weight-units is rather perplexing from local diversity of method.

OTTOMAN MEASURES.

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Stambul pik halebi or arsheen for silks and woollens	2·325 669 feet	2·32501 feet	708·65 millim.
,, draa or pik endeza for cotton and carpets	2·255 602 ,,	2·25496 ,,	687·3 ,,
,, common or Mekka pik	2·250 023 ,,	2·24939 ,,	685·6 ,,
Scutari pik	2·072 016 ,,	2·07143 ,,	631·36 ,,
Albania, Valona pik	2·054 098 ,,	2·05351 ,,	625·9 ,,
,, Arta pik	1·872 120 foot	1·87158 foot	570·45 ,,
,, Negropont pik	2·022 592 feet	2·02202 feet	616·3 ,,
The Turkish berri	1·036 141 mile	0·54693 league	1·667 kilom.
,, ,, agasha or farsang = 3 berri	3·108 422 miles	1·64078 ,,	5·001 ,,
The Arab feddan = 400 sq. gassab = 4 sq. chains	1·458 359 acre	6·34900 sq. chains	0·58982 hectare
Liquid measure :—			
Alma or meter of 8 okas of oil	1·15305 gallon	184·946 fl. ounces	5·2368 litres
Dry measures :—			
Kiloz of 22 okas of wheat	7·73052 gallons	1·23996 cub. foot	35·11 ,,
Fortun = 4 kiloz or 2 canthar of wheat	3·86526 bushels	4·95986 cub. feet	140·44 ,,
Darham = 16 karat or taim = 64 grains	0·113 132 ounce	0·11327 ounce	3·207 grammes
Mitkal = $1\frac{1}{2}$ darham	0·169 699 ,,	0·16990 ,,	4·811 ,,
Cheki or yusdruma = 100 ,,	0·707 077 lb.	11·3269 ounces	320·725 ,,
Rotal or lodar = 176 ,,	1·244 443 ,,	19·9352 ,,	564·47 ,,
Opium cheki = 250 ,,	1·767 693 ,,	28·3172 ,,	801·81 ,,
Oka = 400 ,,	2·828 309 lbs.	45·3075 ,,	1·2829 kilog.
Broussa taffiah (silk-weight) = 610 darham	4·31317 ,,	69·0941 ,,	1·9560 ,,
Negropont rottolo	1·180 156 lb.	18·9054 ,,	0·53531 ,,
Rhodes rotal	5·274 445 lbs.	84·4932 ,,	2·39245 ,,
Scio rotal	1·092 456 lb.	17·5004 ,,	0·49553 ,,
Batman = 6 oka	16·969 852 lbs.	0·27185 ft.-weight	7·6974 ,,
Canthar = 44 ,, = 100 rotal	1·111 169 cwt.	1·99353 ,,	56·45 ,,
Canthar = 45 ,,	1·136 364 ,,	2·03884 ft.-wts.	57·733 ,,

GREEK MEASURES (*before* 1836).[1]

	Eng. Commercial Equiv.		Eng. Scientific Equiv.		French Equivalent.	
Morea, Mistra pik	1·500 650	foot	1·500 224	foot	457·26	millim.
,, Patras pik for woollen fabrics	2·251 335	feet	2·250 606	feet	686·0	,,
,, ,, for silken fabrics	2·084 749	,,	2·08416	,,	635·24	,,
Lepanto pik	2·086 587	,,	2·08600	,,	635·8	,,
Chios large pik	2·251 335	,,	2·25070	,,	686·0	,,
,, small pik	2·166 993	,,	2·16638	,,	660·3	,,
Patras and Morea stremo = 25 square paces	78·9234	sq. yards	7·09905	sq. rods	65·95	mèt. car.
Ionian Islands moggio = 24 zappade = 3200 sq. paces	2·391 853	acres	10·41299	sq. chains	96·7363	ares
Cannata, Patras	2·8211	pints	53·02997	fl. ounces	1·60156	litre
Boccale of wine = 1⅓ cannata, Patras	3·7614	,,	75·41503	,,	2·1354	litres
,, of oil, Patras	3·2110	,,	64·38212	,,	1·823	litre
Cephalonia boccale = $\frac{1}{72}$ barile = 2 quartucci	1·6667	,,	33·41793	,,	0·947	,,
Thiaki boccale = 2 quartucci	1·875	,	37·59517	,,	1·065	,,
Patras barile = 24 boccale	11·2842	gallons	1·80998	cub. foot	51·250	litres
Ionian Islands secchio = 12 boccali of oil	2·500	,,	0·40102	,,	11·35435	,,
,, ,, barile = 4 jari = 6 secchi = 16 miltre	15	,,	2·40609	cub. feet	68·1261	,,
Zante and Cephalonia lira or pagliazza = 8 boccali	1·6667	gallon	0·26735	cub. foot	7·570	,,
Stambul kiloz	7·7305	gallons	1·23996	cub. foot	35·11	,,
Morea bachel	6·5907	,,	1·05713	,,	29·933	,,
Cephalonia bacile	1·375	bushel	1·764	,,	49·95	,,
Thiaki bacile, or Cerigo chilo	0·968 792	,,	1·24314	,,	35·20	,,
Thiaki moggio = 5 bacile	4·84396	bushels	6·21572	cub. feet	1·760	hectol.
Corfu and Paxos misura	4·63479	gallons	0·74342	cub. foot	21·05	litres
,, ,, moggio = 8 misure	4·63479	bushels	5·94732	cub. feet	1·684	hectol.
Patras oka = 400 drachma = 3 Patras pounds	2·64312	pounds	42·3411	ounces	1·1989	kilog.
Ionian Islands oka = 400 drachma = 2·7 lbs. English	2·7	,,	43·2523	,,	1·2247	,,
Talento moderno = English cental	100	,,	1·60193	ft.-weight	0·453 593	quintal
Ordinary Greek oka = 400 drachma	3·371 086	,,	54·0025	ounces	1·5291	kilog.
Greek cantaro = 44 oka	1·324 355	cwt.	2·37611	ft.-weights	0·672 804	quintal
Cantaro of the Ionian Islands = 44 oka	118·80	pounds	1·90310	ft.-weight	0·5388	,,
Patras cantaro = 44 oka	1·038 369	cwt.	1·86301	,,	0·527 516	,,
Morea cantaro = 44 oka	1·104 366	,,	1·98142	,,	0·561 044	,,

[1] For present Greek measures, see the present French metric system.

SYRIAN MEASURES.

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Acra pik	2·274 965 feet	2·27432 feet	693·2 millim.
Aleppo and Alexandretta pik	2·222 127 ,,	2·22150 ,,	677·1 ,,
Damascus large pik	2·074 445 ,,	2·07386 ,,	632·1 ,
,, small pik	1·910 025 foot	1·90948 foot	582·0 ,,
Saide or Sidon pik	1·984 063 ,,	1·98350 ,,	604·56 ,,
Smyrna pik	2·250 023 feet	2·24939 feet	685·6 ,,
Arab mile of 1000 kathuah	1·193 395 mile	0·62993 league	1·9200 kilom.
Arab farsakh = 3 Arab miles	3·580 186 miles	1·88980 ,,	5·760 ,,
Arab feddan = 400 square gassab	1·458 359 acre	6·34900 sq. chains	0·58982 hectare
Dry measures :—			
Smyrna kilo of 32 okas of wheat	1·4119 bushel	1·81177 cubic foot	51·30 litres
Smyrna fortin = 4 kilo	5·6476 bushels	7·24696 cubic feet	2·052 hectol.
Acre ardeb	1·1697 quarter	12·00763 ,,	3·400 ,,
Aleppo makuk of 250 rottal	2·7523 quarters	28·25326 ,,	8·000 ,,
Garavah	4·9860 ,,	51·2090 ,,	14·50 ,,
Acra rottal	4·865 158 pounds	77·93663 ounces	2·2068 kilog.
Aleppo and Alexandretta rottal = 720 darham	5·026 536 ,,	80·52180 ,,	2·2800 ,,
Damascus rottal = 60 wakia . = 600 ,,	3·954 429 ,,	63·34735 ,,	1·7937 ,,
Smyrna rottal or lodar . = 180 ,,	1·274 600 pound	20·42424 ,,	0·5782 ,,
,, taffiah for silk-weight	4·318 853 pounds	69·18517 ,,	1·9590 ,,
,, cheki = $\frac{1}{4}$ oka . = 100 darham	0·708 124 pound	11·34368 ,,	0·3212 ,,
,, opium cheki . = 250 ,,	1·770 311 ,,	28·35920 ,,	0·8030 ,,
Tripoli small rottal . = 600 ,,	4·005 356 pounds	64·16316 ,,	1·8168 ,,
,, large rottal . = 720 ,,	4·806 427 ,,	76·99579 ,,	2·1801 ,,
Aleppo oka . = 400 darham	2·792 520 ,,	44·73433 ,,	1·2667 kilog.
Smyrna oka . = 400 ,,	2·832 497 ,,	45·37472 ,,	1·2848 ,,
Tripoli oka . = 400 ,,	2·670 237 ,,	42·77544 ,,	1·2112 ,,
Aleppo and Alexandretta vesno = 5 rottal	25·132 680 ,,	0·40261 ft.-weight	11·4 ,,
,, ,, zurlo = $27\frac{1}{2}$,,	1·234 194 cwt.	2·21435 ft.-weights	62·7 ,,
,, ,, cola = 35 ,,	1·570 793 ,,	2·81826 ,,	79·8 ,,
Aleppo canthar = 100 rottal	4·487 979 ,,	8·05218 ,,	2·2800 quintals
Damascus ,, = 100 ,,	3·530 740 ,,	6·33474 ,,	1·7937 quintal
Smyrna ,, = 100 ,,	1·138 136 ,,	2·04242 ,,	0·5782 ,,
Tripoli ,, 100 small rottal	3·576 211 ,,	6·41632 ,,	1·8168 ,,

ARAB MEASURES.

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Mekka pik	2·250 023 feet	2·24939 feet	685·6 millim.
Mokha pik	1·583 155 foot	1·58270 foot	482·4 ,,
Betulfakiah pik	1·500 125 ,,	1·49971 ,,	457·1 ,,
Gaz of Mokha and Betulfakiah	2·082 978 feet	2·08239 feet	634·7 ,,
Gassaba or rod = 2 paces	4·200 743 yards	1·25987 rod	3·840 mètres
Chain = 120 ancient feet = 10 gassab	42·00743 ,,	1·25987 chain	38·40 ,,
Arab mile = 6000 ,, = 500 ,,	1·193 395 mile	0·62993 league	1·920 kilom.
Arab farsakh = 3 miles	3·580 186 miles	1·889 798 ,,	5·760 ,,
Baryd = 4 farsakh = 12 miles	14·320 743 ,,	7·55919 ,,	23·040 ,,
Marhala = 24 miles	28·641 485 ,,	15·11838 leagues	46·080 ,,
Square gassab = 4 sq. paces or 144 sq. feet	17·64623 sq. yards	1·58725 sq. rods	14·7456 mèt. car.
Feddan = 400 sq. gassab = 4 sq. chains	1·458 359 acre	6·34900 sq. chains	0·58982 hectare
Liquid measure :—			
Mokha and Betulfakiah nasfiah = 16 vakia	1·6662 pint	33·40856 fl. ounces	0·94593 litre
,, ,, gadda = 8 nasfiah	1·6662 gallon	0·26727 cub. foot	7·56745 litres
Dry measure :—			
Mokha and Betulfakia kella or mecmeda	4·2000 pints	84·21315 fl. ounces	2·38441 ,,
,, ,, teman = 40 kella = 168 pounds of rice	2·6250 bushels	3·36853 cub. feet	95·3765 ,,
Mecca rottal	1·020 607 pound	16·34944 ounces	0·46294 kilog.
Mokha karat	3 grains	6·86543 mils	0·19440 gramme
,, coffala or darham = 16 karat	48 ,,	0·10985 ounce	3·110 352 grammes
,, vakia = 10 darham	480 ,,	1·09847 ,,	31·10352 ,,
,, rottal = 15 vakia	1·500 pound	24·02901 ounces	0·680 389 kilog.
,, coffee rottal = $14\frac{1}{2}$,,	1·450 ,,	23·22805 ,,	0·657 710 ,,
Betulfakiah common rottal = 15 ,,	1·019 395 ,,	16·33002 ,,	0·462 390 ,,
,, coffee rottal = $14\frac{1}{2}$,,	0·985 415 ,,	15·78569 ,,	0·446 977 ,,
,, rottal for dates and iron = 16 vakia	1·087 355 ,,	17·41869 ,,	0·493 216 ,,
Jidda rottal = 15 vakia	0·3660 ,,	5·863 ,,	0·1660 ,,
Mokha farzil = 20 rottal	30 pounds	0·48058 ft.-weight	13·60778 ,,
Betulfakiah farzil = 20 ,,	20·387 896 ,,	0·32660 ,,	9·2478 ,,
,, bale of coffee = 14 farzil	2·548 487 cwt.	4·57241 ft.-wts.	1·294 692 quintal
,, camel load = 2 bales	5·096 974 ,,	9·14482 ,,	2·589 384 quintals
Mokha bahar = 45 farzel	450 pounds	7·20870 ,,	2·041 167 ,,
Betulfakiah bahar = 40 ,,	7·281 370 cwt.	13·06402 ,,	3·69912 ,,
Jidda bahar = 500 Jidda rottal = 100 man	1·633 782 ,,	2·93128 ,,	0·8300 quintal

EGYPTIAN AND ABYSSINIAN MEASURES.

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Cairo pik endezi for Oriental silk	2·095 120 feet	2·09453 feet	638·4 millim.
,, beledi for cloth and cotton	1·865 622 foot	1·86509 foot	568·47 ,,
,, stambul for European silk	2·269 057 feet	2·26841 feet	691·4 ,,
,, mihandeza for land	2·531 932 ,,	2·53121 ,,	771·5 ,,
Alexandria pik endeza	2·061 94 ,,	2·06861 ,,	630·5 ,,
,, beledi	1·837 825 foot	1·83730 foot	560·0 ,,
,, stambul	2·219 502 feet	2·21887 feet	676·3 ,,
Rosetta pik	1·875 139 foot	1·87453 foot	571·35 ,,
Abyssinian pik, nominally Turkish	2·250 679 feet	2·25004 feet	685·8 ,,
The Egyptian feddans are exceedingly numerous.			
An average feddan approximates to the English acre	1 acre	4·35352 sq. chains	40·444 ares
Liquid measures :—			
Abyssinian cuba of honey = 62 English cubic inches.	62 cub. in.	35·86768 fl. ounces	1·0751 litre
Dry measures :—			
Cairo ardeb for flax &c.	4·8000 bushels	6·15959 cub. feet	1·744 027 hectol.
Alexandria kilo = 202 koppen.	4·69447 ,,	6·02590 ,,	1·705 685 ,,
Rosetta ardeb	7·7500 ,,	9·94517 ,,	2·815 877 ,,
Damiad ardeb for rice	11·1800 ,,	14·34672 ,,	4·062 130 ,,
Massowah and Gondar madega	0·7750 pint	18·88113 fl. ounces	0·439 981 litre
Gondar ardeb . . = 10 madega	0·9688 gallon	0·18881 cub. foot	4·399 81 litres
Massowah ardeb . = 24 ,,	2·3250 gallons	0·45315 ,,	10·559 545 ,,
Cairo rotal . . = 144 darham	0·949 905 pound	15·21685 ounces	0·43087 kilog.
Alexandria rotal . = 144 ,,	0·967 763 ,,	15·50291 ,,	0·43897 ,,
Cairo oka or harsela = 400 ,,	2·776 940 pounds	0·44485 ft.-weight	1·25960 ,,
Alexandria oka . = 400 ,,	2·728 618 ,,	0·43704 ,,	1·2375 ,,
Common Cairo canthar = 100 rotal = 36 oka	94·99051 ,,	1·52169 ,,	0·43087 quintal
Alexandria canthar . = 100 ,,	96·77625 ,,	1·55029 ,,	0·43897 ,,
Abyssinian darham	40 grains	91·53911 mils	2·592 grammes
,, wakia . = 10 darham	0·914 286 ounce	0·91539 ounce	25·9196 ,,
,, mocha . = 12 ,,	1·097 143 ,,	1·09847 ,,	31·10352 ,,
,, rotal or liter = 10 mocha	0·685 714 pound	10·98469 ,,	0·311 035 ,,

BERBER, TUNISIAN, AND MOORISH MEASURES.

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Tunis pik for woollen fabrics	2·208 376 feet	2·20774 feet	672·91 millim.
,, for silken fabrics	2·069 949 ,,	2·06937 ,,	630·73 ,,
,, for linen fabrics	1·552 470 foot	1·55202 foot	473·05 ,,
Barbary. Tripoli pik	2·202 272 feet	2·20164 feet	671·05 ,,
Morocco pik	1·749 872 foot	1·74938 foot	533·2 ,,
Tunis matar or metal of wine	2·1679 gallons	0·34769 cub. foot	9·845 litres
,, matar of metal of oil = 2 matar of wine	4·3358 ,,	0·69538 ,,	19·69 ,,
,, millerde = $6\frac{1}{2}$ matar	14·0915 ,,	2·26026 cub. feet	64·00 ,,
Soussa matal of oil	5·2843 ,,	0·84760 cub. foot	24·00 ,,
Tripoli matal of oil, of 42 rotal	5·1390 ,,	0·82429 ,,	23·34 ,,
,, harbaia of $18\frac{3}{4}$ rotal of oil	2·2943 ,,	0·36800 ,,	10·42 ,,
,, wine and spirit barrel = 24 Venetian bozze	14·2677 ,,	2·28851 cub. feet	64·80 ,,
Tunis weba = 12 saa	7·2726 ,,	1·16651 ,,	33·03 ,,
Tripoli temen = 4 orba	5·9088 ,,	0·94776 ,,	26·836 ,,
Tunis caffiso = 16 weba	14·54511 bushels	18·66411 cub. feet	5·2848 hectol.
Tripoli weba = 4 temen	2·9544 ,,	3·79102 ,,	1·07344 ,,
Morocco almud or mud	5·000 ,,	6·41624 ,,	1·816 695 ,,
Tunis rotl = 16 wakia = 128 mitkal	1·110 380 pound	17·78755 ounces	0·50366 kilog.
Tripoli rotl = 16 wakia = 160 darham	1·097 020 ,,	17·57353 ,,	0·49760 ,,
Morocco rotl	1·112 320 ,,	17·81863 ,,	0·50454 ,,
Mogador rotl	1·186 483 ,,	19·00668 ,,	0·53818 ,,
Tripoli and Bengazi oka = $2\frac{1}{2}$ rotal of Tripoli	2·742 549 pounds	43·93382 ,,	1·2440 ,,
Tunis cantar = 100 rotal	109·70195 ,,	1·75735 ft.-weight	0·49760 quintal
Tripoli ,, = 100 ,,	111·03797 ,,	1·77876 ,,	0·50366 ,,
Morocco ,, = 100 ,,	111·23197 ,,	1·78186 ,,	0·50454 ,,
Mogador ,, = 100 ,,	1·05936 cwt.	1·90067 ,,	0·53818 ,,
Bengazi cantar = 125 rotal = 50 oka of Tripoli	1·22435 ,,	2·19669 ft.-weights	0·62200 ,,

ALGERINE MEASURES.

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
The Turkish pik = 8 robi	2·100 371 feet	2·09978 feet	640 millim.
The Moorish or Arab pik	1·575 278 foot	1·57483 foot	480 ,,
The Oran pik	2·251 335 feet	2·25070 feet	686 ,,
Khulleh or khull	3·52288 gallons	0·52975 cub. foot	16·00 litres
Metli or metal of oil, of 20 rotl kebir	3·94122 ,,	0·63217 ,,	17·90 ,,
Tarri	4·36837 ,,	0·70059 ,,	19·84 ,,
Caffiso = 16 tarri	8·73674 bushels	11·20949 cub. feet	3·174 hectol.
Rotal-feudi monetary	1·096 645 pound	17·56753 ounces	0·49743 kilog.
,, attari ordinary = 16 vakia	1·203 900 ,,	19·28568 ,,	0·54608 ,,
,, kebir = $1\frac{1}{2}$ rottal attari	1·644 967 ,,	28·32852 ,,	0·81912 ,,
Oran rottal	1·110 732 ,,	17·79320 ,,	0·50382 ,,
Kanthar-attari ordinary = 100 rottal attari	1·074 911 cwt.	1·92857 ft.-weight	0·54608 quintal
,, for cheese and cotton = 110 ,,	1·182 402 ,,	2·12143 ft.-weights	0·60069 ,,
,, kebir = 150 ,,	1·612 366 ,,	2·89285 ,,	0·81912 ,,
,, for butter, fruit, and oil = 166 ,,	1·784 346 ,,	3·20141 ,,	0·90649 ,,
,, for hemp and flax = 200 ,,	2·149 821 cwts.	3·85714 ,,	1·09216 ,,
,, gharduri for vegetables = $112\frac{1}{2}$,,	1·209 274 cwt.	2·16963 ,,	0·61434 ,,

PERSIAN MEASURES.[1]

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Gira	= 2 bahr	1·137 701 nail	0·21326 foot	65·00 milliers
Zar'	= 4 charak = 16 gira	1·137 701 yard	3·41214 feet	1·04 mètre
Zar' ī yazd wa kirman		1·066 595 ,,	3·19888 ,,	0·975 ,,
Farsakh	= 6000 zar' = 12000 kadam	3·878 535 miles	2·04728 leagues	6·24 kilom.
There are not any square measures, or measures of capacity.				
Kirat	= 16 unā	3·232 376 grains	7·3972 mils	209·4545 m. grammes
The Persian miṣḳāl	= {24 nakhūd = 96 gandum = 4½ dartung = 22 kirāt}	71·112 264 ,,	162·7387 ,,	4·608 grammes
Persian dirham	= 3⅕ miṣḳāl	0·520 135 ounce	0·52076 ounce	14·7456 ,,
,, pinār	= 20 miṣḳāl	3·250 846 ounces	3·25477 ounces	92·16 ,,
,, waḳi'	= 4 nimmih = 90 miṣḳāl	0·914 301 pound	14·64648 ,,	0·41472 kilog.
,, rotal	= 100 miṣḳāl	1·015 889 ,,	16·27387 ,,	0·4608 ,,
,, saddirham	= 8 danar = 16 pinar	3·250 846 pounds	52·07638 ,,	1·47456 ,,
,, man i shah	= 4 saddirham	13·003 386 ,,	0·20831 ft.-weight	5·89824 ,,
Local weight :—				
Tehrān sīr	= 16 miṣḳāl	0·162 542 pound	2·60038 ounces	73·728 grammes
Būshahr giyā	= 48 miṣḳāl	0·487 627 ,,	7·81146 ,,	221·184 ,,
Sīr i shirāz	= 18 miṣḳāl	2·925 762 ounces	2·92930 ,,	82·9444 ,,
Man i shirāz = 4 charak = 8 wakī = 40 sir i shirāz		7·314 405 pounds	0·11717 ft.-weight	3·31776 kilog.
Man i bushahr = 4 charak = 768 miṣḳāl = 16 giyāh		7·802 031 pounds	0·12498 ,,	3·53894 ,,
Man i hāsham = 16 man i bushahr		1·114 576 cwt.	1·99973 ,,	56·6231 ,,
Man i tabrīz = 40 sīr i tahran = 2 saddirham		6·501 693 pounds	0·10415 ,,	2·94912 ,,
Kharwar = 100 man i tabriz = 200 saddirham		5·805 976 cwt.	10·41528 ft.-weights	2·94912 quintals
Ḳara = 100 man i hasham		5·572 880 tons	199·97333 ,,	5·66231 ,,

[1] The French values are those of Captain H. W. Clarke's 'Persian Manual,' 1878.

INDIAN IMPERIAL MEASURES AND MEASURES OF NORTHERN INDIA.

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Girah (nail) . = 3 ungli (digits)	1 nail	0·18745 foot	87·133 millim.
Hath (cubit) . = 8 gheri	1 cubit	1·49957 ,,	0·457 062 mètre
Gaz (yard) . = 2 hath.	1 yard	2·99913 feet	0·914 123 ,,
Bansa . = 5 gaz = 10 hath . . .	5 yards	1·49957 rod	4·570 616 mètres
Kos . . = 2000 gaz	2000 ,,	0·59983 league	1·828 246 kilom.
The English mile = 1760 yards	1 statute mile	0·52785 ,,	1·608 856 ,,
The London mile = 5000 feet (used on the canals) .	1 London mile	0·49986 ,,	1·523 539 ,,
Square gaz . = 4 square hath . . .	1 sq. yard	8·99487 sq. feet	0·835 615 mèt. car.
Square bansa . = 25 square gaz . . .	25 sq. yards	2·24872 sq. rods	20·8904 ,,
Biggah. Bengal = 1600 ,, . . .	1600 ,,	1·43918 sq. chain	13·36984 ares
,, Benares = 3136 ,, . . .	3136 ,,	2·82079 sq. chains	26·20489 ,,
,, Hindustan = 3025 ,, . . .	3025 ,,	2·72095 ,,	25·27735 ,,
,, Orissa . = 4840 ,, . . .	1 acre	4·35352 ,,	40·4440 ,,
,, Tirhut . = 4225 ,, . . .	0·8729 acre	3·8003 ,,	35·30 ,,
In Northern India there are no indigenous measures of capacity, all goods being sold by weight.			
The capacity of a seer of water is	1·64567 pint	32·997 fl. ounces	0·934 275 litre
,, ,, kilogram of water is a legal measure	1·761 440 ,,	35·3166 ,,	1 ,,
,, ,, cubic foot of water in commercial measure	1 cubic foot	0·99914 cub. foot	28·29087 litres
The cubic gaz = English cubic yard. . . .	1 cubic yard	26·97675 cub. yards	7·63853 hectol.
Sindh carwal = 60 cossah = 960 botwai . . .	2·4082 quarters	21·18995 cub. feet	7 ,,
Rupee weight or tola = {16 annas = 100 rutti or gunz = 400 dhan .}	180 grains exactly	0·41193 ounce	11·66382 grammes
Chittak = 5 tola	2·05714 ounces	2·05963 ounces	58·3191 ,,
Ser or seer = 16 chittak = 80 tola	2·05714 pounds	32·95408 ,,	0·933 105 kilog.
Man or maund = 40 ser	82·2857 ,,	1·31816 ft.-weight	37·32421 ,,
The kilogram is also a legal weight in India . .	2·20462 pounds	35·31658 ounces	1 ,,

CHAPTER IV.

PAGAN MEASURES OF EASTERN ASIA, AND THOSE INDIGENOUS TO AFRICA.

THE collections of measures of this type are markedly distinct from Oriental measures introduced and sustained by Moslem preponderance and dominion.

The geographical limit in India accompanying this type may be roughly drawn as a nearly tropical parallel of latitude dividing Northern India from Southern India: though in Asia the general limit is ultra-Indian.

It may be noticed, however, that, though the Moslem religion, and the Moslems themselves, entered into Southern India, parts of Malacca, the Eastern Archipelago, and greatly into China, they never established a firm preponderance and dominion on a very large scale in those regions; had they done so, the indigenous measures would have been generally abolished or modified.

These collections are classified under the heads of—

1. Southern India and Ceylon.
2. Burmah.
3. Thaï (or Siam).
4. Singapore, Malacca, and Prince of Wales Island.
5. Sumatra and Fort Marlborough.
6. Anam (or Cochin China).
7. Java, Borneo, Moluccas, &c.
8. Philippines and Sulu Islands.
9. China.
10. Japan.

Besides these, and in completion of the whole of the Pagan measures now used in the world, there is doubtless a comparatively large number of indigenous primitive measures, about which little or no precise information exists. These would include the measures used by savage and semi-savage tribes and peoples in Central Africa, that are independent of Christian and Moslem influence; also any indigenous American measures surviving among the Red-skins of North America, and the descendants of the Incas, Caribs, Tupi-speaking Brazilians, and Patagonians.

All such units owe their sole importance to the evidence they afford of ethnological distinction, variety, origin, and habit. It is hence much to be regretted that travellers, anthropologists, and scientific men should have comparatively neglected the metrical units of savage and expiring races, although they may now be of no commercial utility.

Reverting to the better-known Asiatic Pagan measures before classified, it will be noticed that they generally have some similarity to ancient European measures.

The cubits of Eastern Asia (see page 59) are mostly approximate natural cubits, or English cubits; the double cubits of Thaï (Siam), Sumatra and Borneo, are approximate English yards; and the fathoms of Burma, Anam (Cochin China), Thaï, Sumatra, China, and Japan, are markedly parallel with European fathoms.

The foot that exists in China and Japan, though markedly missing in Pagan measures generally, is evidently an exceptional unit; the Malabar ady of the Western (Muabbar) coast of India was perhaps imported from Syria or Arabia, but certainly was not

indigenous. The parallelism between ancient China and ancient Egypt and Chaldæa leads to the presumption that the Chinese, and consequently also the Japanese foot, was Chaldæan by origin; while all European feet were of Roman or Christian derivation, never indigenous ancient units. The Kymri, whether in Britain, Gaul, or the Kimmerian Chersonese, never had any foot-unit, as far as is now known. The Kymric Welsh had a *goad*, of about $27\frac{1}{2}$ English inches, which was probably divided into halves, quarters, and eighths, independently of any foot; although it may have been by origin a sacred cubit.

The general resemblance between ancient European and present Asiatic Pagan units is hence most striking; any few exceptions to the rule regarding the absence of the foot can but aid in establishing the main principle.

The rods of Pagan-Asia are mostly double-fathoms; the exception being the rod of China, which is a double-pace of ten local feet; large units corresponding to the pole exist in some countries in addition to the rod; also some rather large chains; the itinerary units, approximate furlongs, leagues, and journeys are rather varied.

The surface-units of Pagan-Asia, both small and large, are necessarily also very diverse in value, yet among them may be noticed the biggah of Orissa, identical with the English acre of 4840 square yards, also the Sumatra square orlong, which is identical with the Madras kānī (in vulgar English cawney), a very convenient unit of 6400 square yards, giving a corresponding linear orlong or kānī-side of exactly eighty yards. Similarities of this kind cannot be justly attributed to mere hazard, or fortuitous accident.

Capacity measures, shown in the various parahs,

markals, baskets, gantangs, balli, kula, &c., mentioned on pages 183, 184, and 189, form the chief distinctive between the Pagan and Oriental-Moslem systems of measure; in the latter none or hardly any such units exist. This peculiarity extends also to large capacity units, as shown by the garsah, lasts and coyan, given at page 191.

In the Asiatic-Pagan units of weight, the tching or king (Anglicè, catti) is the unit corresponding to the pound in a large number of cases; it is used in China, Japan, the Chinese Archipelago, and through a great portion of Eastern Asia. In some cases, however, the principal unit of weight is a double pound, but this is more generally a monetary catti, as that of Malacca, Acheen, Singapur, and Thaï. The Kachcha sers, or seers of Southern India are exceedingly variable, and are mostly less than a pound, corresponding to the former English troy pound; but the vis of Southern India, Burma, and Malacca, and the variable catti-utan of Sumatra are mostly approximate triple pounds, and are the commercial standard weight-units.

The *kachcha man* of Southern India is an approximate quarter (English weight - quarter 14 pounds) peculiar to that country, but not very much used even there, as the next larger unit, the kandi, with its quarters and eighths, throws it out of employment. This *kachcha man*, an improper or incomplete maund, must be distinguished both from the very *small man* of Turkey, Syria, Arabia, and Persia, which is a stone, and from the *pakka*, real, proper, or large *man* of Northern India, and man-i-hasham of Persia and Mesopotamia, which are approximate hundredweights. The term *man* is applied to units of these three sorts,

probably from the reason that the word meant a stone in some language, and that all such corn-weighing units were practically stones of various sizes. The similarity between the kachcha man of Southern India and the proper or large man of Northern India solely consists in their being in each case composed of forty sers ; but as the North-Indian ser was a large unit and the South-Indian kachcha ser was a small unit, the difference in value is very great. There are, however, a few exceptional cases that can be easily accounted for by ethnological and historic causes. In the main, the kachcha man is an indigenous Pagan unit quite distinct and peculiar ; it is yet a most troublesome unit in any system, and its total obliteration from the measures of the world would hence be advantageous.

Among Pagan weight-units, the load, generally termed the *bahār* or *kandi*, holds a prominent position ; its value ranges between three and six English hundredweight as extremes, with a mean of about $3\frac{1}{2}$ or 4 hundredweight (see page 234). Its formation is various, according as it is based on a pound, or ching, a double pound, or a vis or triple-pound ; it has in most cases degenerated as regards simplicity and directness of multiple, from having been forced by English commerce into another form, its nearest equivalent in avoirdupois pounds.

Proceeding to the largest weight-units corresponding to English tons and lasts, these appear rare among Pagan measures ; the garsah of Southern India and Ceylon is the only one of which full record exists ; possibly there may be others that have not attracted notice. The garsah when a weight-unit is about 4 tons ; but it might perhaps be more strictly considered a

doubtful or nominal unit partly of capacity and partly of weight; although there are sufficient grounds for treating the garsah separately as a weight-unit and as a capacity-unit of dry measure. See pages 191 and 237.

Pagan systems of measures may on the whole be considered as but little inferior to either Oriental or European systems. Decimalisation has been carried out thoroughly by the Chinese and Japanese. Perfect systematisation is only known to exist in the measures of Thaï (Siam), which have been lately reorganised; the capacity units being cubicised on the niu, and standards supplied by the English Warden of the Standards. The ordinary common defect in Pagan, as well as in Oriental and European systems, is that the weight-units are not systematised or adjusted to cubic measure, and thus remain independent, arbitrary multiples of coins frequently long obsolete.

In thus completing an account of the measures of the world, it becomes necessary to apologise for the absence of indigenous African, Australasian, and American measures in this book. Communications have been opened with travellers which may eventually result in procuring detailed and trustworthy information on the subject. At present vague and general statements alone exist. The indigenous savage African apparently most often adopts a fathom as a standard unit of length, and divides it into four natural cubits; the weight units are apparently very diverse and arbitrary, shells, berries, and eggs; and the capacity units are gourds and calabashes.

Among indigenous African measures, those of Guinea and of Madagascar have been longest known to a partial extent. The *jacktan* of Guinea is a rod or double

fathom, reputed to be 12·005 English feet in value; the *refe* of Madagascar is a fathom reputed at 6·56 English feet, but it appears also to be very variable, generally varying between 4 and 6 feet in different provinces. The indigenous capacity measures of Guinea are not yet forthcoming—it is said that Abyssinian measures, the kuba and ardeb, are used there; but those of Madagascar show an evident connection with those of the Chinese Archipelago, whence former immigrations came.

The series is thus:—

1 zatu = 8·5 trubahuash = 17 bambu = 100 voules.

The zatu is thus about 7·339 gallons, the voule 0·5867 pint, and the bambu 1·7614 quart.

In Guinea, the weight-units are peculiar:—
1 benda = 2 benda offa = 4 egebba = 8 piso = 16 agerac or aki = 32 media tabla; the value of the benda being 989·6 grains, or about 2¼ ounces, and the media tabla 30·925 grains; these are monetary units used for gold dust. There is also a kanthar, subdivided into 5 gamel, which may be of Moslem and of Moorish origin, although it is unusually large, 0·9635 ton.

In Madagascar there is also a series of monetary weight-units as follows:—

1 sompi = 2 vari = 3 sacare = 6 nanki = 12 nanke,

the sompi being about 60 grains, and the nanke 5 grains.

In some portions of Africa various Moslem units are employed, Arab, Egyptian, and Moorish; near the old Portuguese settlements, Mozambique and Loando, old Portuguese measures are in use. At the Cape of Good Hope, and in Southern Africa, though English measures are now generally employed, and formerly Dutch units

were in use, there were also some compounded measures of capacity that afford some idea of the old indigenous measures ; they were :—

Last = 46 balli ; balli = 5 gantang,

the last being 7·283 quarters, and supposed to represent a capacity holding 3200 troy Dutch pounds of wheat ; and the balli 1·266 bushel, holding 500 troy Dutch pounds of wheat. The arrangement of units and their names are similar to some in Sumatra and at Batavia ; but whether they were brought over by the Dutch or by the native immigrants at an earlier epoch, and afterwards merely modified by the Dutch as regarded value, is a matter that may perhaps be considered doubtful ; although the latter appears more probable. This probability is further supported by the analogy of the bambu of Madagascar, which is most markedly a unit of Sumatra derivation.

SOUTH INDIAN AND CINGALESE MEASURES.

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Indian Imperial hath	1·500 foot	1·49957 foot	0·457 062 mètre
Indian Imperial gaz or yard	1 yard	2·99913 feet	0·914 123 ,,
For local South Indian hath and gaz, see tables in Part I.			
Goanese cubit	2·233 feet	2·23269 feet	680·413 millim.
Cingalese cubit	1·542 foot	1·54155 foot	469·859 ,,
Malabar adye or foot	10·46 inches	0·87141 foot	0·265 603 mètre
,, culey = 24 ady	20·92 feet	2·09139 rods	6·37449 mètres
,, also a culy = 26 ady	22·663 ,,	2·26564 ,,	6·905 697 ,,
Baroach and Malwa wassa = 20 wiswassa	7·4666 ,,	7·46449 feet	2·275 170 ,,
Surat wassa = 20 wiswassa	8·1333 ,,	8·12097 ,,	2·478 290 ,,
Trichinopalli kolu	21·1666 ,,	2·11605 rods	6·449 647 mètres
Kos = 2000 gaz Imperial	2000 yards	0·59983 league	1·828 246 kilom.
Madras kani = 6400 square gaz Imperial	6400 sq. yds.	5·75668 sq. chains	53·47936 ares
Baroach and Malwa bigga = 400 square wassa	2477·83 ,,	2·22878 ,,	20·70521 ,,
Surat bigga = 400 square wassa	2940·05 ,,	2·64454 ,,	24·56751 ,,
Bombay bigga	3406 ,,	3·06365 ,,	28·46105 ,,
Madras measure = 8 olluck	100 cub. ins.	57·8209 fl. ounces	1·63721 litre
,, parah = 5 mercal = 40 measures	4000 ,,	2·31284 cub. feet	65·4884 litres
Bombay grain parah = 28 ser measures	2·02927 gallons	0·32551 cub. foot	9·216 417 ,,
,, salt parah = $2\frac{6}{7}$ grain parah	5·79792 ,,	0·93002 ,,	26·33263 ,,
,, anna = 4 morah = 100 salt parah	9·05925 quartrs.	93·00211 cub. feet	26·33263 hectol.
,, rash = 16 annas	144·918 ,,	1488·034 ,,	421·322 ,,
Anjar culsey = 16 shai = 64 mapp	13·6875 bushels	17·56445 ,,	4·97320 ,,
Travancor parah = 10 dangalli	2·875 pints	57·6461 fl. ounces	1·575 302 litre
Cochin parah = 45 local measures	7·000 gallons	1·12284 cub. foot	31·79218 litres
Madura mercal = 6 ,,	2·367 ,,	0·37968 fl. ounce	10·750 298 ,,
Colombo mercal = 12 ser measures = 48 chandu rās	780 cub. ins.	0·45064 cub. foot	12·77024 ,,
,, ammonam = 8 parah = 16 marcal	12480 ,,	7·21025 cub. feet	2·043 238 hectol.

SOUTH INDIAN AND CINGALESE MEASURES—(*continued*).

	Eng. Commercial Equiv.		Eng. Scientific Equiv.		French Equivalent.	
Madras vis . . =400 varahan	3·125	pounds	50·06045	ounces	1·417 477	kilog.
,, kandi . = 20 man = 160 vis	500	,,	8·00967	ft.-weights	2·267 964	quintals
Bombay ser . = 30 paise or pice	11·20	ounces	11·21354	ounces	317·52	grammes
,, kandi . = 20 man = 800 ser	5	cwt.	8·97083	ft.-weights	2·54012	quintals
Goanese kandi or bahar = 20 man = 480 rattel	4·419 084	,,	7·92858	,,	2·2450	,,
Cingalese kandi or bahar	500	pounds	8·00967	,,	2·267 964	,,
Madras and Ceylon garsah = 20 kandi	10000	,,	160·1934	,,	4·06419	milliers

See local values of the candy in Part I.

BURMESE MEASURES.

	Eng. Commercial Equiv.		Eng. Scientific Equiv.		French Equivalent.	
Ordinary taim = 18 paulghaut	1·500	foot	1·49957	foot	457·062	millim.
Royal saundaung = 22 ,,	1·833 333	,,	1·83280	,,	558·6313	,,
Dha or bamboo = 7 saundaung	12·833 333	feet	1·28296	rod	3·910 419	mètres
Dain . . = 1000 dha	2·430 555	miles	1·28296	league	3·910 419	kilom.
Square saundaung	3·361 111	sq. feet	3·35920	sq. feet	31·2068	déc. car.
,, dha . = 49 square saundaung	18·299 383	sq. yards	1·64601	sq. rod	15·291 332	mèt. car.
Rangun teng or basket	0·83333	bushel	1·0693	cub. foot	30·278	litres
Pegu teng or basket	0·848225	,,	1·0884	,,	30·819	,,
Rangun tical . = 100 moos	$233\frac{1}{3}$	grains	0·53398	ounce	15·11976	grammes
,, vis . = 100 tical	3·3333	pounds	53·3978	ounces	1·511 976	kilog.
Pegu tical . = 100 moos = $4\frac{1}{2}$ pagodas	237·5	grains	0·54352	ounce	15·38994	grammes
,, vis . = 100 tical = 4 agito = 8 abucco	3·3929	pounds	54·35196	ounces	1·538 994	kilog.
Rangun kandi = 150 vis	500	,,	8·00967	ft.-weights	2·267 964	quintals
Pegu kandi . = 150 vis	508·93	,,	8·15279	,,	2·308 491	,,

THAÏ (OR SIAMESE) MEASURES.

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Standard temperature 85° Fahr.			
Niu	0·833 inch	0·69425 tithe	21·16024 millim.
Küb = 12 niu	10 inches	0·83310 foot	0·25392 ,,
Sok = 2 küb	$1\frac{2}{3}$ foot	1·66619 ,,	0·50785 mètre
Ken = 2 sok	$3\frac{1}{3}$ feet	3·33239 feet	1·01569 ,,
Wa = 2 ken	$6\frac{2}{3}$,,	6·66477 ,,	2·03138 mètres
Sen = 20 wa	$133\frac{1}{3}$,,	1·33295 chain	40·62766 ,,
Tod = 4 sen	0·80808 furlong	5·33182 chains	162·5107 ,,
Roeneng = 25 tod	2·52525 miles	1·33296 league	4·06277 kilom.
Square sen = 400 square wa	1·623 487 rood	1·77677 sq. chain	16·5061 ares
Cubic niu	0·5787 cub. in.	0·33461 fl. ounce	9·4746 cent. cub.
Thanan = 100 cubic niu	57·87 ,,	33·46105 fl. ounces	0·94746 litre
Thangsat = 20 thanan	1157·41 ,,	0·66922 cub. foot	18·9492 litres
Old units { Seste = 40 sat	2·2018 bushels	2·82533 cub. feet	80 ,,
Old units { Cohi = 40 seste	11·009 quarters	113·0131 ,,	32 hectol.
Bat	0·535 ounce	0·53565 ounce	15·167 grammes
Chang or ching = 80 bat	2·675 pounds	42·85177 ounces	1·21336 kilog.
Hap = 50 chang	1·1942 cwt.	2·14259 ft.-weights	60·668 ,,
Monetary sompay = 2 pay = 4 clam = 48 grs. of rice	14·111 grains	32·2926 millim.	0·91437 grammes
Commercial tical = $\frac{1}{4}$ tael	$118\frac{1}{8}$,,	0·27030 ounce	7·65 ,,
Monetary tical = 4 miam = 8 fuang = 16 sompay	225·775 ,,	0·51668 ,,	14·63 ,,
Also, the Malacca catti = 20 tael = 80 tical (com.)	1·3499 pound	21·62434 ounces	0·61235 kilog.
At Cancao and in Camboja an English catti	1·3333 ,,	21·35906 ,,	0·60479 ,,
Malacca pecul = 100 Malacca catti	1·21776 cwt.	2·16243 ft.-weights	0·61235 quintal
At Cancao and Camboja the English pecul = 100 English catti	1·1905 ,,	2·13591 ,,	0·60479 quintal

ANAM OR COCHIN CHINA.

		Eng. Commercial Equiv.		Eng. Scientific Equiv.		French Equivalent.	
Tak	= 10 fan = 100 li	1·92	inch	1·599 536	tithe	48·7532	millim.
Thuok (or cubit)	= 10 tak	1·60	foot	1·599 536	foot	0·48753	mètre
Ngu	= 5 thuok	8	feet	7·99768	,,	2·437 662	mètres
Truon	= 2 ngu = 10 thuok	16	,,	1·599 536	rod	4·875 324	,,
Sao	= 3 ,, = 15 ,,	8	yards	2·399 304	rods	7·312 986	,,
Chai vai	= 6 ,, = 30 ,,	16	,,	4·798 608	,,	14·62597	,,
Mao	= 10 sao = 150 ,,	80	,,	2·399 304	chains	73·12986	,,
Quo	= 20 ,, = 300 ,,	160	,,	4·798 608	,,	146·25972	,,
Li	= 3 quo = 60 sao	480	,,	1·439 582	cable	0·438 779	kilom.
Pou	= 10 li = 5 dain	2·72727	miles	1·439 582	league	4·387 792	,,
Square ngu		64	sq. feet	63·9631	sq. feet	5·94215	mèt. car.
Square sao	= 9 square ngu	64	sq. yards	5·756 678	sq. rods	0·534 79	are
Square mao	= 100 square sao	6400	,,	5·756 678	sq. chains	0·534 79	hectare
Hao		$6\frac{2}{9}$	gallons	0·998 08	cub. foot	28·2597	litres
Tao	= 2 hao	$12\frac{4}{9}$	,,	1·99616	,,	56·5194	,,
Dong	= 10 fan = 100 li = 1000 hao &c.	0·1375	ounce	0·137 666	ounce	3·89806	grammes
Luong	= 10 dong	1·375	,,	1·376 662	,,	38·9806	,,
Kan	= 16 luang	1·375	pound	22·026 584	ounces	0·62369	kilog.
Yen	= 10 kan	13·75	pounds	220·26584	,,	6·2369	,,
Tan	= 10 yen = 100 kan	137·5	,,	2·202 658	ft.-wts.	62·369	,,
Quan	= 5 tan	6·1384	cwt.	11·013 292	,,	3·11845	quintals

N.B.—The values given are mean or approximative values; the real values vary locally to a considerable degree.

MALACCA, SINGAPORE, AND PRINCE OF WALES ISLAND.

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Singapore asta / Prince of Wales Island asta	1·5 foot	1·49957 foot	457·062 millim.
Malacca ordinary cubit	1·522 ,,	1·52156 ,,	463·765 ,,
Prince of Wales Island depah = 4 asta	2 yards	5·99826 feet	1·82825 mètre
,, ,, jamba = 2 depa	4 ,,	1·19965 rod	3·65649 mètres
,, ,, orlong = 20 jamba	80 ,,	2·39930 chains	73·12986 ,,
Square depa	4 sq. yds.	35·97948 sq. feet	3·34246 mèt. car.
Square jamba P. of W. Island = 4 square depa	16 ,,	1·43918 sq. yard	13·36984 ,,
P. of Wales Island sq. orlong = 400 square jamba	6400 ,,	5·75668 sq. chains	53·47936 ares
Singapore and P. of Wales I. gantang = 4 chupa	3·91920 quarts	0·15716 cub. foot	4·45 litres
Singapore and P. of Wales I. pecul or sack = 20 gantang	2·44950 bushels	3·14318 cub. feet	89·00 ,,
Singapore and P. of Wales I. coyang = 40 pecul or sacks	12·24751 ,,	125·727 ,,	35·60 hectol.
Malacca gantang	3·52288 quarts	0·14127 cub. foot	4·00 litres
,, sack = 10 gantang	1·10090 bushel	1·41266 ,,	40·00 ,,
,, last = 50 sacks	6·88063 quarters	70·63316 cub. feet	20 hectol.
,, coyang = 80 mass or 4800 lbs. T.D.	11·0090 ,,	113·0130 ,,	32 ,,
Singapore & P. of W. I. English catti = $1\frac{1}{3}$ lb. Eng.	1·3333 pound	21·35906 ounces	0·60479 kilog.
Malacca commercial catti = 16 tales	1·3500 ,,	21·62612 ,,	0·61235 ,,
,, monetary catti = 20 buncal	2·0491 pounds	32·82522 ,,	0·92946 ,,
,, tampang = Dutch catti	1·3564 pound	21·72864 ,,	0·6152 ,,
,, kip = 15 bedur = 30 tampang	40·692 pounds	0·65186 ounce	18·456 ,,
Tocopa vis = 4 poot	5·950 ,,	95·31508 ounces	2·69888 ,,
Jansalan vis = 4 ,,	6·0671 ,,	97·18411 ,,	2·751 795 ,,
Queda catti	1·621 pound	25·96895 ,,	0·73532 ,,
,, hali = 16 ganta	32 pounds	0·51262 ft.-weight	14·51497 ,,
Singapore &c. the English pecul = 100 English catti	133·333 ,,	2·13591 ft.-weights	0·60479 quintal
Malacca pecul of 100 Malacca catti	135·0 ,,	2·16261 ,,	0·61235 ,,
Queda bahar = 15 hali or nali	480 ,,	7·68928 ,,	2·177 246 quintals
Singapore &c. the bahar = 3 English pecul	400 ,,	6·40774 ,,	1·814 371 quintal
Malacca the bahar = 3 Malacca pecul	405 ,,	6·48784 ,,	1·83705 ,,
Tocopa bahar = 80 viss = 320 poot	476 ,,	7·62521 ,,	2·159 102 quintals
Janselon Island bahar = 80 viss = 320 poot	485·333 ,,	7·77473 ,,	2·201 436 ,,

SUMATRA AND FORT MARLBOROUGH.

	Eng. Commercial Equiv.		Eng. Scientific Equiv.		French Equivalent.	
Fort Marlborough jankal = 4 tempoh	9	inches	0·74978	foot	228·531	millim.
,, esto = 2 jankal	1·500	foot	1·49957	,,	457·062	,,
Ordinary Sumatra etto	1·560	,,	1·55955	,,	475·344	,,
The Chinese chih or foot is also used	1·0594	,,	1·0591	,,	322·81	,,
Fort Marlborough hailah. = 2 esto	1	yard	2·99913	feet	0·914 123	mètre
,, depo or gochih = 2 haila	2	yards	5·99826	,,	1·828 246	,,
,, tung = 2 depo	4	,,	1·19965	rod	3·656 493	mètres
Fort Marlborough square esto	2·25	sq. feet	2·24872	sq. feet	20·8905	déc. car.
,, ,, haila = 4 sq. esto	1	sq. yard	8·99487	,,	0·835 615	mèt. car.
,, ,, depo = 4 sq. haila	4	sq. yards	35·97948	,,	3·342 460	,,
,, ,, tung = 4 sq. depo	16	,,	1·43918	sq. rod	13·36984	,,
Sumatra pakha for liquids and dry goods	0·9686	pint	19·42121	fl. ounces	0·54985	litre
,, sukat = 12 pakha	1·453	gallon	0·23312	cub. foot	6·59823	litres
,, tub = 10 sukat	1·816	bushel	2·33115	cub. feet	65·9823	,,
,, coyan = 80 tub	18·16	quarters	186·492	,,	52·78584	hectol.
Acheen coyan = 100 nelli = 800 bambu	6·004	,,	61·63	,,	17·45	,,
Fort Marlborough and Bencoolen kula or bamba = 4 chupa	252	cub. in.	145·5916	fl. ounces	4·4204	litres
Fort Marlborough and Bencoolen coyang = 800 kula	12·16605	quarters	116·4733	cub. feet	35·3632	hectol.
Palembang gantang of 6 cattis	1·07888	gallon	0·17305	cub. foot	4·9	litres
,, bally = 10 gantang	1·34860	bushel	1·73051	,,	49·0	,,
,, coyang = 80 bally	13·48604	quarters	138·441	cub. feet	39·2	hectol.
Sumatra generally. English catti = $1\frac{1}{3}$ lb. English	1·3333	pound	21·35906	ounces	0·60479	kilog.
Acheen catti = 20 buncal = 100 tael = 280 pagoda	2·1171	pounds	33·91454	,,	0·960 301	,,
Palembang. The Dutch catti = $1\frac{1}{4}$ lb. Dutch troy	1·3564	pound	21·72864	,,	0·615 254	,,
Ft. Marlb. Mocamoco catti = 16 tael = 24 ringit	1·4583	,,	23·36102	,,	0·661 475	,,
Sinkel Island catti for benzoin = 56 English ounces	3·50	pounds	56·0677	,,	1·587 574	,,
,, ,, camphor = 56 Eng. troy oz.	3·84	,,	61·5143	,,	1·741 796	,,
The catti-utan = 3 ordinary English cattis	4	,,	64·0774	,,	1·814 371	,,
Sumatra tompong = 60 ordinary English cattis	80	,,	0·12816	ft.-weight	36·28742	,,
Sinkel tompong = 29 Sinkel catti for benzoin	70	,,	0·11214	,,	31·75149	,,
Sumatra pecul = 100 English catti	$133\frac{1}{3}$	,,	2·13591	ft.-weights	0·60479	quintal
Sumatra and Bencoolen bahar = 560 lbs. English	5	cwt.	8·97083	,,	2·54012	quintals
Acheen bahar = 200 Acheen catti	3·7805	,,	6·78291	,,	1·92060	quintal

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Java Bantam cubit	1·650 foot	1·64953 foot	502·768 millim.
,, Batavia cubit	2·250 feet	2·24935 feet	685·592 ,,
Moluccas Amboyna cubit	1·522 foot	1·52156 foot	463·765 ,,
Philippines cubit, or codo castillan of Manila	1·3702 ,,	1·36860 ,,	417·5 ,,
Java Bantam gantam = 8 bambu; or 40 lbs. T.D. rice	5·7247 gallons	0·91823 ,,	26 ,,
,, ,, coyang = 200 gantam	17·8896 quarters	183·64622 cub. feet	52·0 hectol.
Java Batavia gantam	2·1137 gallons	0·33934 cub. foot	9·60 litres
,, Batavia balli = 5 gantang	10·5686 gallons	1·6952 ,,	48·0 litres
,, ,, coyang = 46 balli; or 3375 lbs. T.D. rice	7·8185 quarters	77·69648 cub. feet	22·0 hectol.
Moluccas Amboyna coyang of 25 pecul or 3000 lbs. T.D. rice	6·7086 quarters	68·86733 ,,	19·5 ,,
Borneo gantang of 16 cattis or 20 lbs. T.D. rice	2·8623 gallons	0·45912 cub. foot	13·0 litres
Celebes. Macassar indigenous gantang of 7⅔ lbs. T.D.	1·1009 gallon	0·17658 ,,	5·0 ,,
,, ,, export gantang of 11½ lbs. T.D.	1·6513 ,,	0·26487 ,,	7·5 ,,
Mindanao gantang containing 4 English catti (rice)	1·4091 quart	113·013 fl. ounces	3·20 ,,
,, battel = 10 gantang; Sulu Islands raga = 10 gantang } identical	3·5229 gallons	1·13013 cub. foot	32 ,,
,, bubut of 5 English catti of rice	3·5229 quarts	141·266 fl. ounces	4·00 ,,
Java, Celebes, and Borneo Dutch catti = 1¼ lb. T.D.	1·3564 pound	21·72864 ounces	0·615 254 kilog.
Molucca catti = 1⅕ lb. Troy Dutch	1·3022 ,,	20·86038 ,,	0·590 669 ,,
Banda (Molucca) catti = 6$\frac{1}{10}$ lbs. English	6·1000 pounds	97·7210 ,,	2·766 915 ,,
,, soekel = 28 catti of Banda	170·8 ,,	2·73610 ft.-weights	77·473 620 ,,
Java, Celebes, and Borneo Dutch pecul = 100 D. catti	135·64 ,,	2·17286 ,,	0·615 254 quintal
Molucca pecul = 100 Molucca catti	130·22 ,,	2·08604 ,,	0·590 669 ,,
Banda bahar = 100 Banda cattis	610 ,,	9·77180 ,,	2·766 915 quintals
Java ,, = 3 Dutch pecul	3·6333 cwt.	6·51858 ,,	1·845 762 quintal
Molucca bahar = 3 Molucca pecul	3·4880 ,,	6·25812 ,,	1·772 007 ,,
Batavia amat = 2 Dutch pecul	2·4222 ,,	4·34572 ,,	1·230 508 ,,
,, timpang = 5 ,,	6·0555 ,,	10·8643 ,,	3·076 270 quintals
Manila gold tola = 10 piastres	0·59664 pound	9·5578 ounces	0·270 631 kilog.
,, silk tola = 11 piastres or onzas	0·65629 ,,	10·5134 ,,	0·297 694 ,,
Manila. The Spanish catti = 22 Spanish onzas	1·3946 ,,	22·34057 ,,	0·632 580 ,,
Mindanao and Sulu Islands. The English catti	1·3333 ,,	21·35906 ,,	0·604 79 ,,
Philippines. Spanish pecul = 100 Spanish catti	139·46 pounds	2·23406 ft.-weights	0·632 58 quintal
Sulu Islands. English pecul = 100 English catti	133·33 ,,	2·13591	0·604 79 ,,

CHINESE MEASURES, *based on the old value of the Kambuchih or Board of Works Standard.*

		Eng. Commercial Equiv.		Eng. Scientific Equiv.		French Equivalent.	
Tsun	= 10 fan = 100 li	1·2713	inch	1·0591	tithe	0·03228	mètre
Chih	= 10 tsun	1·0594	foot	1·0591	foot	0·3228	,,
Pu or gochih	= 5 chih	1·0594	pace	1·0591	pace	1·614	,,
Chang	= 10 ,,	3·53136	yards	1·0591	rod	3·228	mètres
Yu or yin	= 10 chang	6·42066	poles	1·0591	chain	32·281	,,
Li	= 18 yu	2·88929	furlongs	1·9064	cable	10·58106	kilom.
Pou	= 10 li	3·61162	miles	1·9064	league	5·81058	,,
Tsan	= 8 pou	28·89296	,,	15·2512	leagues	46·48464	kilom.
Square chih		1·1223	sq. foot	1·1217	sq. foot	0·1042	mèt. car.
Square pu, or kung	= 25 square chih	3·1177	sq. yards	1·1217	sq. pace	2·60515	,,
Square chang	= 100 ,,	12·4709	,,	1·1217	sq. rod	10·4205	,,
Kish	= 60 kung	0·1551	rood	16·3254	sq. rods	1·5631	are
Mao	= 4 kish = 240 kung = 10 fan	0·6205	,,	67·3016	,,	6·2524	ares
Square yu	= 100 square chang	1·0341	,,	1·12169	sq. chain	10·4206	,,
King	= 6 square yu = 10 mao	1·5512	acre	6·73016	sq. chains	62·5236	,,
Tching = 10 koh, subdivided decimally to millionths		1·2302	pint	24·72	fl. ounces	0·7	litre
Tao	= 10 tching	1·5413	gallon	247·22	,,	7	litres
Ho	= 5 tao	7·7063	gallons	1·2361	cub. foot	35	,,
Tche	= 10 tao = 2 ho	15·4126	,,	2·4722	cub. feet	70	,,
Ping	= 8 tche	15·4126	bushels	19·7776	,,	5·60	hectolitres
Tchen or lui	= 10 shu	0·1325	ounce	0·1327	ounce	3·751	grammes
Liang	= 10 lui or tsien	1·3252	,,	1·3268	,,	37·506	,,
Tching	= 16 liang	1·3252	pound	21·229	ounces	0·6011	kilog.
Tan	= 100 tching	1·1832	cwt.	2·1229	ft.-weights	60·11	,,

JAPANESE MEASURES.

		Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Sung	= 10 bu = 100 ring	1·18902 inch	0·990 567 tithe	30·19196 millim.
Shaku (ordinary)	= 10 sung	0·99085 foot	0·990 567 foot	0·301 920 mètre
Shaku for land		1·035 247 ,,	1·034 952 ,,	0·315 448 ,,
Kujirad-shaku for fabrics, haberdashery, &c.		1·25 ,,	1·249 638 ,,	0·377 399 ,,
Go-shaku	= 5 shaku	4·95425 feet	4·952 835 feet	1·509 598 ,,
Keng	= 6 ,,	5·94510 ,,	5·943 402 ,,	1·811 518 ,,
Chu	= 60 keng = 360 shaku	118·902 yards	3·566 041 chains	108·6911 mètres
Ri	= 36 chu = 12960 shaku	2·432 086 miles	1·283 775 league	3·912 878 kilom.
Square shaku ordinary		0·981 784 sq. foot	0·981 223 sq. foot	9·11553 déc. car.
Square shaku for land		1·071 736 ,,	1·071 126 ,,	9·95065 ,,
Ijje	= 30 subo = 1000 landshaku	119·081 747 sq. yards	10·71126 sq. rods	0·995 065 are
Ittau	= 10 ijje = 10000 ,,	0·984 147 rood	1·071 126 sq. chain	9·95065 ares
Itchu	= 10 ittau	2·460 367 acres	10·71126 sq. chains	0·995 065 hectare
Göo, subdivided decimally to millionths		0·319 504 pint	6·406 714 fl. ounces	0·181 408 litre
Shöo	= 10 göo	3·195 042 pints	64·067 139 ,,	1·814 081 ,,
To	= 10 shöo	3·993 802 gallons	0·640 671 cub. foot	18·14081 litres
Koku	= 10 to	4·992 252 bushels	6·406 714 cub. feet	1·814 081 hectol.
Nomme	= 10 fan = 100 ring, &c.	58·24 grains	133·494 mils	3·77999 grammes
Riome	= 4 nomme	0·5333̇ ounce	0·533 976 ounce	15·11976 ,,
King	= 40 riome = 160 nomme	1·3333̇ pound	21·35906 ounces	0·60479 kilog.
Tan	= 100 king	1·19047 cwt.	2·13591 ft.-wts.	60·47903 ,,

INDIGENOUS AFRICAN MEASURES.

	Eng. Commercial Equiv.	Eng. Scientific Equiv.	French Equivalent.
Madagascar refe (one value)	6·5618 feet	6·5599 feet	1·8575 mètre
,, voule	0·586 696 pint	11·77219 fl. ounces	0·33$\dot{3}$ litre
,, bambu = 6 voules	1·761 420 quart	70·63316 ,,	2·00 litres
,, trubahuash or monka = 2 bambu	3·522 840 quarts	0·14127 cub. foot	4·00 ,,
,, zatu = 100 voules	7·339 333 ,,	1·17722 ,,	33·33$\dot{3}$,,
,, nanki = 2 nanke	10 grains	22·88478 mils.	647·99 milgr.
,, sacare = 2 nanki	20 ,,	45·76955 ,,	1·29598 gramme
,, vari = 1½ sacare	30 ,,	68·65433 ,,	1·94397 ,,
,, sompi = 2 vari	60 ,,	0·13731 ounce	3·88794 grammes
Cape of Good Hope gantang	2·025 656 gallons	0·32491 cub. foot	9·20 litres
,, ,, balli = 5 gantang	1·266 035 bushel	1·62456 ,,	46·00 ,,
,, ,, last = {46 balli, or 3200 lbs. T.D. wheat}	7·283 451 quarters	74·72987 cub. feet	21·16 hectol.
The jacktan of Guinea	12·005 feet	1·20015 rod	3·658 017 mètres
Guinea. The kuba and ardeb of Abyssinia are said to be used.			
Guinea mediatabla	30·925 grains	141·5425 mils.	4·0078 grammes
,, agirac or aki = 2 mediatabla	61·85 ,,	0·28309 ounce	8·0156 ,,
,, piso = 2 agirac	123·7 ,,	0·56617 ,,	16·0313 ,,
,, benda-offa = 2 egebba = 4 piso	494·8 ,,	1·13234 ,,	32·0625 ,,
,, benda = 8 piso = 16 agirac	989·6 ,,	2·26468 ounces	64·1251 ,,
,, gamell	3·85415 cwt.	6·91498 fwt.	1·958 quintal
,, kantar . 5 gamell	0·96354 ton	34·5749 ,,	0·979 millier

CHAPTER V.

MEDICINAL AND LAPIDARIES' SYSTEMS.

IT is comparatively recently that in Europe medicinal weights and measures have been incorporated in the commercial weights and measures of various countries and nations; in some cases, more notably in Russia, this has not yet been effected, while in England the transition is now merely imperfectly effected. In Oriental countries under Moslem sway, the medicinal weights, the dram and its subdivisions, appear to have always formed part of the commercial measures, and never a segregated collection; in Pagan countries the monetary weights most frequently served also as medicinal weights; and generally in olden time compounding was effected entirely by weight, and independently of measures of capacity.

The adoption of three distinct systems of commercial, of monetary, and of medicinal weight, appears to have been confined to European nations. The typical European unit of monetary weight was the old Cöln marc of 8 ounces, with which the old English or Anglo-Saxon marc was nearly identical; the typical unit of commercial weight in Europe was not a solitary unit, for it is probable that some one Oriental rotal, rottolo, or arratel, or a variety of them, formed the basic units in Southern

Europe, while in Northern Europe the double-marc became the commercial pound; the typical or basic unit of medicinal weight in Northern Europe was the Nürnberg pound of 12 ounces, or marc and a half of Nürnberg, though in Southern Europe no corresponding single unit of medicinal weight retained any such marked importance.

Treating the matter broadly, the monetary unit commonly used was an eight-ounce marc, the medicinal unit was a twelve-ounce pound, and the commercial unit was a sixteen-ounce pound; but these marcs and pounds generally belonged to different systems or scales of measure, before their incorporation into a single one.

Immediately this incorporation is effected, the medicinal pound becomes either obsolete or merely nominal, the commercial ounce of the nation becomes the medicinal ounce, and its mode of subdivision into smaller units alone retains importance in its bearing on the compounding of drugs.

Under these circumstances, which are generally true of Europe in the nineteenth century (the period to which this book is intended to apply), the values of the *medicinal ounce* and its various modes of subdivision in Europe form the principal part of any useful information on this subject; these will be found at the end of this section in tabular form, arranged under the heads of the various nations to which it applies.

On referring to it, it will be noticed that the typical mode of subdividing the ounce in Northern Europe is the Nürnberg method.

1 ounce = 8 drams = 24 scruples = 480 grains.

In Southern Europe, in Italy, Spain, Portugal, and France, the mode was

1 ounce = 8 drams = 24 scruples = 576 grains,

the difference between the two consisting in dividing the scruple into 20 grains in Northern Europe, and into 24 grains in Southern Europe. In some cases the obolus of half a scruple and in others the carat of four grains were units used in addition to the above. The Neapolitan mode of subdivision formed the only exception to the above general type.

The introduction of metric measures in France, Italy, and the Netherlands in the earlier part of this century and in other countries in recent times, had for its principal effect on medicinal weights the abolition of pounds, ounces, and grains, and the substitution of the gramme for the scruple which it nearly represented ; the gramme thus became the unit of metric medicinal weight, and its decimal multiples and sub-multiples became nominal measures. (See 'Medicinal Measures of France, Italy, and the Netherlands.')

In England the medicinal measures are particularly unfortunate, not having yet gone through their transition stage, and not being yet cleared of the difficulties resulting from borrowing in ancient times from France both the Troy grain and the avoirdupois pound. The medicinal weight is still old Troy weight, but medicinal measures of capacity are avoirdupois fluid ounces with submultiples. The best remedy for this would be in accordance with general improvement of the system ; the adoption of an English millesimal ounce, $\frac{1}{1000}$ of the foot-weight ; and the subdivision of this ounce into 1000 mils or thousandths. See also 'Pro-

posed Systems' at the end of the book. Under any circumstances, the medical measures of capacity, the fluid ounce, fluid dram, and fluid grain (or liquid grain as it is officially termed); or the fluid mil, on the other method, should correspond with the weights of similar name. This correlation is preserved in the French System, where the centimètre cube corresponds to the gramme.

The entire abolition of separate medicinal measures of all sorts, and the unification of a national series of measures, is the natural course of development, and constitutes progress in this special branch of measures.

Lapidaries' Systems.

Diamonds, pearls, and precious stones are frequently estimated in weight-units, distinct from both the commercial and medicinal measure of the country or place. They are mentioned as weighing a certain number of carats; these carats are almost invariably divided into four grains, and these grains are further divided into quarters, sixteenths and sixty-fourths, on a binary scale. Such carats vary in value in various countries, although they may be mere departures from some original *κεράτιον*, perhaps an ancient Alexandrian carat, or in later times from the Amsterdam carat.

The estimation of the value of rough and cut diamonds is a matter closely allied to the values of the carat as a weight-unit, and requires some explanation. The value of an uncut diamond varies with the square of its actual weight expressed in carats; thus, taking a price of £2 per carat, the value of a five-carat uncut diamond is $5 \times 5 \times 2 = £50$. The value of a five-carat cut diamond, which has lost about half its weight in cutting,

similarly estimated at a price of £2 per carat, but is based on the square of double its actual weight in carats; thus $10 \times 10 \times 2 = £200$.

In most places pearls are estimated in diamond-carats; in others there are special pearl-carats, of different value. There are also both real and nominal weight-units applied to pearls. For instance, Bombay pearls are first estimated by weight in *tanks* of real weight; the tank being = 24 ratti (see table), or 72 English grains; they are secondly estimated in nominal *chows* by calculation thus. The square of the number of *tanks* multiplied by 330 and divided by the number of pearls weighed, gives the number of chows; and the current price is applied to the chow. If 50 pearls weigh 4 tanks, and the chow is worth 12 rupees, their value =

$$\frac{4 \times 4 \times 330 \times 12}{50} = 1267{\cdot}2 \text{ rupees, or about } £126.$$

Madras pearls are differently estimated; they are first weighed in *mangals* of real weight-units, and then estimated in *Madras chows* by calculation thus. Three quarters of the square of the weight of the pearls in mangals is divided by the number of the pearls weighed to obtain the number of *chows*, and the current price is then applied to the Madras chow. Thus, if 60 pearls weigh 50 mangal, and the price of the Madras chow be 40 rupees, the value of the pearls $= \frac{3}{4} \times \frac{50 \times 50 \times 40}{60} =$ 1250 rupees, or £125.

In both such cases the chow is a mere nominal unit of estimation; although there is also an Indian chow that is a real weight-unit.

The term *carat,* when applied to precious metals, gold and silver, is not a weight-unit, but a mere mode of

expressing the purity or fineness of the metal in twenty-fourths. Thus 18-carat gold is metal in which 18 parts out of 24, or three-fourths, are pure gold; the remaining 6 parts, or one-fourth, being alloy. This method of estimating fineness is due to the old marc having been divided into twenty-four real carats, or actual weight-units. The more modern method is to estimate fineness in thousandths; thus gold 750 fine has 250 parts alloy, and corresponds to 18-carat gold; three-quarters of the metal being pure gold in each case.

Reverting to the real carats of various nations, their values will be found in a table immediately following the tables of medicinal measure in this chapter.

Besides these carats, there are in some countries other weight-units that are used for precious stones, and occasionally for precious metal also. One of the most notable of these is the Indian *gonj*, *gunja*, or *gundumini*; it is by origin a hard scarlet pea, dotted with black, which when dry is very invariable in weight; its weight is also termed a *ratti* or *rutti;* but in a few places the gonj and the ratti are distinct, the latter having become an abstract unit apart from the former, subsidiary to the tolah or weight of the local rupee.

Another of the more notable of these weight-units used for precious stones and precious metal is the *candarin*, or condorine, or cantarai, also termed by the Chinese a *fun* or *fan*, and by the South-Indians a *fanam*, and used all over the Indo-Chinese Archipelago. This is by origin a large lentil, or pea, of a pinkish colour dotted with black, about double the size of the *gonj*, and possessing the same quality of very slight variability of weight when dry; is probably a variety of the same botanic genus or species. The value when reduced to

absolute standard became a subsidiary part or sub-multiple of the weight of some local coin, rupee or pagoda, or a decimal fraction of some local ounce or tchen, as in China and Japan. The term *candarin*, vulgarised by the English into condorine, is probably a Portuguese corruption of the Indian word *cantarai*; the word *fanam* is also Indian, but the word *fan* or *fun* is Chinese, though perhaps of South-Indian origin, and now denotes not only the tenth of a chien or ounce, but is a general term for a tenth, or a decimal fraction.

The values of the ratti and the fanam are given in tables following that of the carat, at the end of this chapter.

MEDICINAL MEASURES OF WEIGHT AND OF CAPACITY.

NUREMBERG WEIGHT.

THE medicinal pound of Nuremberg, $= \frac{3}{4}$ Nuremberg monetary pound, was formerly universally adopted in Germany and Russia :

	English	French
Value of the Nuremberg pound	5522 grains =	357·85 grammes
The Nuremberg ounce $= \frac{1}{12}$ pound	460·17 grains =	29·821 grammes

The subdivision of the Nuremberg ounce was :

Ounce		Drachms		Scruples		Oboles		Grains	Grammes
1	=	8	=	24	=	48	=	480	29·821
		1	=	3	=	6	=	60	3·726
				1	=	2	=	20	1·243
						1	=	10	0·622
								1	0·062

Compounding was then mostly done by weight.

In modern times the commercial ounce of various nations has been mostly taken as the unit of medical weight. The Nuremberg or German mode of subdivision into 480 grains is used by most northern nations of Europe ; the French mode by southern nations.

DENMARK, NORWAY, AND GERMANY.

The Nuremberg pound and ounce are generally adopted, with their typical subdivision, for medicinal purposes. (See also Prussia, Austro-Hungary, and Bavaria.)

SWEDEN.

The Swedish medicinal pound is $\frac{103}{123}$ of the skålpund, and is 7410 as.

Value of the medicinal pound = 5478·5 English grains = 355 grammes.
Value of the medicinal ounce = 456·54 English grains = 29·583 grammes.

Its subdivision follows the Nuremberg type as given above.

ENGLAND.

The medicinal weights and measures are now in a state of transition.

At present (1881) the English medicinal ounce (for weight) is the old Troy ounce of 480 grains ; this grain being identical with the commercial grain (a Troy grain).

The subdivision of the medicinal ounce is thus :

Troy Ounce		Med. Drachms		Scruples		Grains	Grammes
1	=	8	=	24	=	480	31·103
		1	=	3	=	60	3·888
				1	=	20	1·296
						1	0·065

The English medicinal measures of capacity are arranged on two alternative systems, based on the commercial fluid ounce at 62° Fahrenheit normal temperature.

First

Fluid Ounce		Fluid Med. Drms.		Minims	Cubic Centim.
1	=	8	=	480	28·350
		1	=	60	3·544
				1	0·059

Secondly

Fluid Ounce		Fluid Med. Drms.		Liquid Grains	Cubic Centim.
1	=	8	=	437·50	28·350
		1	=	54·69	3·544
				1	0·0648

The latter system is not yet customary, although standards have been supplied to the public.

A preferable mode of subdivision may be used for technical purposes, both in weight and in capacity, thus,

1 ounce = 1000 mils	1 foot-weight = 1000 ounces
1 fluid ounce = 1000 fluid mils	1 cubic foot = 1000 fluid ounces

but this method is not yet customary.

PRUSSIA.

The medicinal ounce is identical with the commercial ounce. Value of the ounce 451·11 English grains, or 29·232 grammes. Its subdivision follows the Nuremberg type (see preceding page) into 480 medicinal grains.

AUSTRO-HUNGARY.

The medicinal ounce is identical with the commercial ounce. Value of the ounce 540·19 English grains, or 35·004 grammes. Its subdivision follows the Nuremberg type (see preceding page) into 480 grains.

BAVARIA.

The medicinal ounce is identical with the commercial ounce. Value of the unze 462·97 English grains, or 30 grammes. Its subdivision follows the Nuremberg type, or it may be divided into grammes, and decimal parts of the gramme.

RUSSIA.

The Russian medicinal funt = $\frac{7}{8}$ commercial funt, and is divided into 12 ounces.

Medicinal pound = 5529·765 Eng. grs. = 358·323 grammes
Medicinal ounce = 460·814 ,, = 29·860 ,,

The subdivision of the ounce into 480 grains is that of the Nuremberg type (see above).

The former Russian medical weights were those of Nuremberg.

The former Polish medicinal pound of 1819 was fixed at 358·5 grammes = 5532·49 grains English, and the ounce at 29·875 grammes = 461·04 grains English; its subdivision was like that of Nuremberg.

FRANCE.

The gramme is the unit of medicinal weight; and the cubic centimètre or millimètre that of medicinal capacity; the decimal multiples and submultiples of both are solely employed.

1 gramme . . = 15·4321 English grains
1 cubic centimètre = 15·4321 ,, liquid grains

the mode of subdivision is:—

1 kilogramme = 1000 grammes = 1 000 000 milligrammes
1 gramme = 1000 milligrammes

and

1 litre = 1000 centim. cub. = 1 000 000 millim. cub.
1 centim. cub. = 1000 millim. cub.

From 1812 to 1840, the mesures usuelles were:—

the livre usuelle = 500 grammes = 7716·05 English grains
the once ,, = 32 ,, = 493·83 ,,

and the following was the mode of subdivision (codex):—

Once		Gros		Grammes		Grains
1	=	8	=	32	=	640
		1	=	4	=	80
				1	=	20

Before 1840, the livre = 367·13 grammes = 5665·67 English grains
the once = $\frac{1}{12}$ livre = 30·594 ,, 472·14 ,,

and the following was the old French mode of subdivision:—

Once		Drachmes or Gros		Deniers or Scrupules		Grains
1	=	8	=	24	=	576
		1	=	3	=	72
				1	=	24

This old French mode of subdivision into 576 grains was typical in Southern Europe, and was employed in Italy, Spain, and Portugal.

ITALY.

Metric units as in France, but with local names:—

Oncia = 100 grammes = 1543·210 English grains
Grosso = 10 ,, = 154·321 ,,
Denaro = 1 gramme = 15·432 ,,
Grano = 0·1 ,, = 1·543 English grain

The former Italian medicinal ounces were local light commercial ounces, or twelfths of the light commercial pound, peso sottile, and had the following values :—

Tuscany	28·296 grammes	= 436·67	English grains
Roman States of the Church .	28·258 ,,	= 436·08	,,
Sardinia, Genoa . . .	25·617 ,,	= 395·32	,,
,, Turin . . .	26·500 ,,	= 408·95	,,
Lombardy, Milan . .	27·233 ,,	= 420·37	,,
Venetia, Venice . . .	25·108 ,,	= 387·47	,,
Kingdom of Naples . .	26·729 ,,	= 412·49	,,

The typical mode of subdivision was, excepting at Venice and Naples, the same as the old French method, into 576 grains (see France).

At Venice, the sazio of one-sixth of the ounce was an additional unit of subdivision.

The Neapolitan mode of subdivision into 10 drams was of Oriental type.

Onzia		Drammi		Trapezi or Scrupoli		Acini
1	=	10	=	30	=	600
		1	=	3	=	60
				1	=	20

The Netherlands.

The metric units as in France, but with local names :–

Ons		Lood		Wigtje or Gramme		Korrel
1	=	10	=	100	=	1000

The medicinal pound of Holland and Belgium was $\frac{3}{8}$ kilogram = 375 wigte or grammes.

For values of metric units, see France and Italy.

Switzerland.

At present the French metric measures are used for medicinal purposes. From 1822 till lately the old mesures usuelles (see France); before 1822, the Nuremberg pound in most cantons, but at Basle, Friberg, Berne, Neufchatel, and Soleure the older Parisian livre of 12 onces poids de marc of 367·13 grammes.

For all these see France, and Nuremberg measures.

Spain and Portugal.

The Spanish and Portuguese medicinal ounces are identical with the respective commercial ounces.

Spanish ounce	= 443·67 English grains	= 28·75	grammes
Portuguese ounce	= 442·75 ,,	= 28·69	,,

The mode of subdivision is the same in both cases, and is nearly identical with the typical old French mode.

Onza		Ochavas or Dracmas		Escrupulos		Caracters		Granos
1	=	8	=	24	=	144	=	576
		1	=	3	=	18	=	72
				1	=	6	=	24
						1	=	4

The Levant.

The Venetian medicinal weights (see Venice, Italy). Also Oriental commercial dirhams, &c. (see Commercial Systems of Turkey, Syria, &c.)

Oriental Countries.

The medicinal weights are identical with both the commercial and the monetary weights, all of which are arranged in a single system. See subdivisions of commercial measures.

Pagan Countries.

The medicinal weights for compounding are identical with the monetary weights in many cases; in others sufficient information is not available.

TABLE OF MEDICINAL OUNCES.

In some cases identical with commercial ounces.		English Commercial Equivalent. Grains	English Scientific Equivalent. Mill. oz.	French Scientific Equivalent. Grammes
Denmark & Norway. Nuremberg ounce	=480 grains.	460·17	1·0532	29·821
Sweden. Medicinal ounce .	=480 grains	456·44	1·0448	29·583
England. Troy ounce . .	=480 grains	480	1·0985	31·103
" Millesimal ounce .	=1000 mils	436·97	1	28·315
Prussia. Commercial ounce .	=480 grains	451·11	1·0324	29·232
Austro-Hungary. Com. ounce	=480 grains	540·19	1·1362	35·004
Bavaria. Commercial ounce .	=480 grains	462·97	1·0595	30
Germany. Nuremberg ounce .	=480 grains	460·17	1·0532	29·821
Russia. Medicinal ounce .	=480 grains	460·81	1·0546	29·860
France, Italy, Netherlands, Switzerland, and Greece. The gramme .	=1000 milgr.	15·43	0·0353	1
Spain. Commercial ounce .	=576 grains	443·67	1·0154	28·750
Portugal. Commercial ounce	=576 grains	442·75	1·0132	28·690
Levant. Venetian com. ounce .	=576 grains	387·47	0·9574	27·108

MEDICINAL MEASURES OF CAPACITY.

	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Fluid oz.	Fluid oz.	Cent. cub.
England. Fluid ounce avoir. = $437\frac{1}{2}$ liquid grains = 480 minims	1	1·0025	28·386
England. Fluid ounce millesimal = 1000 fluid mils	0·9975	1	28·315
France. Centimètre cube = 1000 millimètres cube	0·0352	0·0353	1

N.B.—For details, see preceding pages.

LAPIDARIES' WEIGHT-UNITS.

Reputed values of the carat. The carat invariably is = 4 carat grains.	English Commercial Equivalent.	English Scientific Equivalent.	French Scientific Equivalent.
	Grains	Mils.	Milgrs.
England. Diamond carat	3·168	7·250	205·3
,, Pearl carat	3·200	7·323	207·4
Germany. Kölnische diamant-karat . .	3·171	7·257	205·5
Austro-Hungary. Vienna diamond carat .	3·181	7·280	206·1
Holland. Amsterdam diamond carat . .	3·165	7·243	205·1
Russia. Amsterdam diamond carat . .	3·165	7·243	205·1
France. Old diamond carat = 3·876 grains poids de marc	3·177	7·270	205·9
Spain. Diamond carat = 4 Castilian grains .	3·085	7·060	199·9
Portugal and Brazil. Quilate = 4·132 granos peso de mardo	3·176	7·268	205·8
Italy. Bologna carat	2·910	6·660	188·6
,, Florence carat	3·033	6·941	196·5
,, Turin carat	3·295	7·543	213·5
,, Venice carat	3·196	7·314	207·1
Turkey. Kara, killo or taim	3·094	7·081	200·5
Egypt. Alexandrian kerat	2·959	6·772	191·7
Arabia. Mokha karat	3	6·865	194·4
Persia. Kirāt = 16 una	3·232	7·397	209·5
India. English diamond carat	3·168	7·250	205·3
Java, Borneo, &c. A Dutch carat of 4·096 as	3·038	6·952	196·9

For China, Japan, and the Chinese Archipelago, see fan, fanam, or candarin.

LAPIDARIES' WEIGHT-UNITS —*continued.*	Number to a tola.	English Commercial Equivalent. Grains	English Scientific Equivalent. Mils.	French Scientific Equivalent. Milgrs.
Values of the gonj or ratti.				
Bombay gonza = 6 chow . . .	100	1·790	4·095	116·0
Puna gunja = 2 wat	96	1·997	4·570	129·4
Ahmadnagar, Chandor, & Nassick gonja	96	1·960	4·485	127·0
Bombay ratti = 13¾ takka = 16 ana . .		3	6·865	194·4
Ahmadabad ratti	96	2·015	4·611	130·6
Aurangabandar ratti = 24 mūn . .	72	2·486	5·689	161·1
Calcutta ratti = 4 dhān = 8 nelli = 16 pankho	100	2·246	5·140	145·5
Calcutta pearl ratti or pakka ratti . .		2·825	6·465	183·1
Dehli jewellers' ratti		1·250	2·861	81·0
Jaulna ratti = 2 wheat grains = 4 urd-grains = 8 rice grains	96	1·923	4·401	124·6
Malwa ratti = 8 chaul		1·979	4·529	128·2
Patna ratti		3·050	6·980	197·6
Sindhi ratti = 24 mūn	72	2·486	5·689	161·1
,, pearl ratti = 8 hubla . . .		16	36·616	1036·8
Surat ratti = 6 chauwal	96	1·953	4·469	126·6
,, pearl ratti = 20 vassa . . .		2·846	6·513	184·4
Values of the fan, fanam, or candarin.				
Bangalur fanam or cantarai = 4 grumatri = 16 paddy grains	30	5·870	13·433	380·4
Ballari fanam or cantarai . . .	30	5·875	13·445	380·7
Calicut fanam, 11½ to a miskāl . .		5·800	13·273	375·8
Cochin fanam	31	5·796	13·264	375·6
Pondicheri fanam = 16 nelli . . .		5·871	13·436	380·4
Masulipatam chunam or fanam . .	30	5·968	13·657	386·7
Madras. Mangal = 16 ana . . .		6	13·731	388·8
Sumatra. Bencoolen fanam or candarin.		6·380	14·601	413·4
,, Natal fanam or candarin .		5·840	13·365	378·4
,, Padang fanam or candarin .		6·360	14·555	412·1
Moluccas. Timor fanam or candarin .		5·800	13·273	375·8
Sulu Islands. Chusuk or candarin .		5·833	13·349	378·0
China. Fan, or candarin = 10 li or cash		5·798	13·269	375·7
Japan. Fan (old value) = 10 ring . .		5·688	13·217	368·6
,, Modern value of fan = 10 ring .		5·824	13·328	377·4
Madagascar. Nanke		5	11·442	324·0

CHAPTER VI.

ON SCIENTIFIC SYSTEMS.

WHILE a commercial system of measures has for its principal object the convenience of the general public and of the wholesale and the retail tradesman, in buying and selling any saleable commodity, and in measuring, weighing, and subdividing it in accordance with a rigid unalterable set of commercial units of known value and fixed ratio, a scientific system of measures on the contrary may be almost independent of retail trade-convenience, and, comparatively speaking, unsuited to purposes of ordinary and frequent measuring and weighing. Thus, while in a commercial system some recognised suitable unit with an appropriate mode of subdivision must be forthcoming at almost every point where any branch of trade may require one, such a heavy demand is not made on a scientific system, which is sufficiently complete in this respect, if it supplies only one unit of length, one of surface, one of capacity, and one of weight, in accordance with the commercial measures of the same country.

A scientific set of measures is made use of by a comparatively very small section of the public, scientific and professional men, who are nearly indifferent to the units of retail trade, the pecks, pots, and pounds, and the quarters, eighths, and sixteenths of perpetual daily

weighing and measuring; in fact, for the purposes of a certain number of scientific men, a set of scientific measures belonging to any foreign nation, and totally disconnected with their own national commercial system, might be quite suitable, provided it was convenient in other respects. For professional men, however, who form a connecting link between scientific men and the general public, it is an absolute necessity that the scientific system shall have the small amount of accordance with the commercial measures of their own country already mentioned.

The second distinctive element in a scientific system is that, as convenience of calculation on an extensive scale is more important than facility in measuring, weighing, and subdividing, the decimal mode of subdivision, with decimal multiples and submultiples, becomes as necessary in it as a binary or a mixed binary-decimal subdivision is in commerce; for the professional man wishes to calculate with facility from the ounce to the bushel, from the pint to the ton (using commercial units for illustration) or from the gallon to the acre and the inch, while the retail tradesman and those dealing with him calculate in a very limited range peculiar to one single trade.

In the third place, the scientific and professional man is contented with units set far apart, such as hundreds or thousands of the next lower unit, while the tradesmen requires his commercial units at comparatively short distances, generally counting and dividing merely to quarters, eighths, twelfths, or sixteenths before coming to another commercial unit of distinctive name and value, from which he may make a fresh start in his small calculations.

The fourth distinctive element in a perfect scientific system is that the standard units, though few in number, should be absolutely correct and truly determined, most especially in the connection between the standard unit of capacity or cubic measure and the standard unit of weight; any defect in this respect being liable to vitiate the deductions and calculated results of scientific men, many of which are based on very small and excessively meagre data, and are thus liable to superimposed and cumulative error from such a cause. As regards the connection between the standard unit of cubic measure or capacity, which in a scientific system are identical, and the standard unit of weight, there is no doubt that the method of comparison by distilled water at its utmost density—that is, at a temperature of about 39° Fahrenheit—has been accepted as the most convenient mode in principle, and that most commonly recognised as the best at present. Whether it really is so or not may be doubtful, but the determination of this point should rest with special experts. When the investigations and labours of scientific men have arrived at a preferable liquid of uniform density, at a solid of uniform density preferable to a brass or platinum weight, and at an improved mode of conducting scientific comparisons of weight and capacity on a far larger scale than is at present usual, an immensely higher degree of exactitude will be attainable. At present only one of these three important desiderata has been arrived at in the form of the quartz weights introduced by Steinheil.

There is, however, another desideratum that would give a stimulus to the development of all the others; it is that the governments of civilised countries should depart from the old methods of accepting gratuitously

the labours of scientific men, or of nominally and tardily rewarding the latter by some official post, the retention of which may require courtierlike finesse and intrigue rather than skill. When the whole system of charitable patronage of scientific labour and of appropriating foreign results is swept away, and when substantial encouragement replaces detraction, more rapid progress may be expected in this branch of science.

As regards actual scientific systems of measures, very few may be said to exist at present. In ancient times commercial measures were formed on a scientific basis, were developments from a set of scientific units, or derived from a scientific system. The ancient Babylonian, Egyptian, Indian, the Hashemic, Ptolemaic, Greek, and Roman systems, were all scientific, being based on a cubit or a foot, and the weight of water or of wine contained in a cubic cubit or a cubic foot.

Ancient Scientific Systems.

The earliest of these ancient scientific systems, of which any mention is made, appears to have been Chaldæan; and it is very probable that the earliest of the Egyptian and Phœnician systems were Chaldæan by origin. Both decimal and sexagesimal modes of subdivision were employed at a very early epoch; but the systems were probably very simple, and unembarrassed by an infinity of commercial requirements; a cubit once determined and accurately fixed, its square, its cube, and the weight of water, wine, or grain in its cube, were four standard units of length, surface, capacity, and weight; the rest was probably nearly left to the habits of the people. The cubits themselves were very various, and

perhaps changed with each dynasty as the foot does in China to the present day; but there is also sufficient reason to suppose that some of these ancient cubits were geodetic, or based either on a theoretical geodetic unit, or a measured terrestrial arc; some were historic, and venerated for their antiquity; and others were carefully systematised, so that the submultiples of the weight-units dependent on them might be in convenient accordance with monetary and commercial requirements. About this purely-cubitic period there is little direct evidence, its probable existence can only be inferred from analogies that appear conclusive.

At a later period, the foot, diversely derived from natural, royal, and sacred cubits, became the recognised standard unit; and the same principles were applied to it. The talent or foot-weight of water, wine, or grain was the unit of weight, and was divided either sexagesimally into manáh or pounds, or into fiftieths and hundredths in the decimal mode. The ancient weights, discovered by Layard (see Layard's 'Nineveh and Babylon') and now existing in the British Museum, afford ample evidence of the modes adopted in this period. This historic method of dealing with the foot and the talent as standard units has never yet been improved upon, and is as applicable in England in the present day as it ever was. (The revival of the English foot-weight as a legal unit in 1859 affords evidence of this.) It has unfortunately been considered fashionable to decry this ancient system as unscientific, and to overrate the importance of the modern French system from a scientific point of view. No valid reason can be urged against the existence of carefully computed and ingeniously arranged metrical units and systems at the earliest

periods, when the Chaldæans, the Phœnicians, and the Egyptians were the civilised races. Ignorance and barbarism may be imputed to them, but cannot be proved except as regards the masses. Of our own ignorance and barbarism at the present day as regards an infinity of subjects there is not the slightest doubt; our ignorance also extends to not knowing enough about the ancients, and their scientific doings (which were necessarily secluded), to be able to say what they could not do; it is hence safer to assume that they could do about as much as ourselves in most matters, although probably in very different ways, and with very different means and appliances.

When we reflect on the vastness of the ancient Tyrian mole, in comparison with our puny breakwaters; on the stupendous Egyptian pyramids and monoliths compared with our buildings and fragmentary monuments; on the 20-ton shot used by the Turks at the siege of Byzantium, and not yet attempted by ourselves, and on many other similar or corresponding facts, we cannot but conclude that skill of a high description must have been employed in such matters, and that the vastness and grandeur of scale was not due to a thoughtless or coarse aggregation of small things.

Comparatively uncivilised races at the present day can achieve wonderful results with hardly any visible appliances or mechanism; travellers meet with many such cases, of which one may be quoted in illustration. After the Burmese war, a very heavy bell was taken as a trophy, lowered from a pagoda, and, probably from mismanagement, never arrived at the ship; it was left imbedded on the muddy shore; the English could not move it. One day a Burmese ecclesiastic asked if he

might have the bell, as the English apparently did not want it; he was informed that he might take it, if he could; the next morning the bell was hanging in its former place at the pagoda.

Can we reasonably believe that the Phœnicians and Chaldæans were less skilful than the Burmese?

As regards geodesy and astronomy in ancient times, it is possible that the masses may have considered the stars to be holes pricked through a concave, and the earth a plane bounded by an immensity of ocean; but the enlightened priests, chiefs, and astrologers could not have had such ideas. The ruins of enormous observatories in India prove that angular observations must have been made with very minute accuracy, even though verniers and micrometers may have been wanting. The knowledge of cycles, the Chaldæan Saros, the Indian Vrihaspati Chacram or cycle of Jupiter, and the Indian very correct knowledge of lunar motions, were based on actual and extended series of astronomical observations. Yet a large number of persons at the present day would not hesitate to assert that 'black people, without even a telescope, could not possibly know much about astronomy.'

Some corresponding argument is also used to prove that the ancients could not measure a geodetic arc, nor even weigh or measure anything with precision. The following is one:—

'It is obvious that without a thermometer or other'
'adequate means, and without a barometer or knowledge'
'of pressure and density of air, all weighings and measur-'
'ings must have been wanting in scientific precision.'

The want of uniformity in the battered specimens of ancient weights and measures that now exist is also

brought forward as an argument against precision in early periods. Yet how would a few stray unselected specimens of English units, Anglo-Saxon, British, early Elizabethan standards (condemned as inaccurate), Georgian and Victorian, appear to anyone two thousand years hence?

It is quite true that the appliances and means employed for many purposes in ancient times are wholly unknown to us. The ancients and their astrologers had, however, always the privilege of choosing a lucky moment and a secluded place for their operations ; their moments and their places and conditions may have been well selected, so as to secure uniformity of temperature as well as other objects ; they may also have had some superior knowledge about the animal and the vegetable world which could be utilised in a way rendering many of our present appliances quite unnecessary within certain limits. Also, by employing very large units, they may through them have arrived by some process of their own at accurate submultiples with quite as much accuracy as is now done with small units and minute instrumental readings.

There is therefore no more cogent reason for disbelieving the powers of the ancients to measure a geodetic arc than to compute the cycle of Jupiter.

It has been believed for a long time that the Great Pyramid, though probably a tomb, was also a perfect storehouse of standard Egyptian units of measurement, length, surface, capacity, and weight ; and that the units of length were also formed on a geodetic basis. Many have taken measurements there, and their deductions differ widely ; yet this would hardly be sufficient ground for condemning the opinion. It is far more probable

than otherwise that any constructors would under any circumstances build a mass of that description in accordance with, and in some definite ratio to, the units of measurement used by them; and this probability would hold independently of any presumed object in forming a permanent record of those units for future reference. It would also be more convenient to the constructors that certain standard units should be adhered to throughout the work.

The discrepancies in the measurements of the base of the Great Pyramid made at various times may be easily accounted for; the base is irregularly covered up by accumulations of sand, the visible base is therefore a very fluctuating length, and even if shafts be sunk at the corners, and horizontal measurements made between them, there is yet then some doubt as to which is the real exact base, or where the original foundation ceased.

The astronomer Ptolemy determined the base to be 600 Phileterian feet, $=690$ English feet, and to be also $\frac{1}{500}$ of a degree of the meridian; the most modern measurements by the English Ordnance Surveyors made the base about 760 English feet, or nearly $\frac{1}{480}$th of the mean degree.

Taking this latter as correct, a side would then be nearly an eighth of a minute, and the sum of the four sides half a minute; so that there still remains as much reason as ever to believe that some geodetic unit was used in the construction of the Great Pyramid; and perhaps also more than one.

Ancient authors assert that the length of one of the sides of the Great Pyramid was 500 cubits; presuming these to have been natural cubits from which the natural Egyptian, Phœnician, and Olympic foot was derived by

taking two-thirds of it; the natural cubit, 1·520 English feet, and the natural foot, 1·013 English foot, must both have been geodetic units. Taking another view of the matter, and supposing that a sacred cubit was the unit adopted, of 2·111 English feet, the length of the base would be nearly if not exactly 360 sacred cubits; a species of sexagesimal stadium in harmony with ancient Chaldæan multiples, and corresponding to the Chinese li of 360 paces as regards mode of formation; in that case the sacred cubit may also have been geodetic in origin.

It is beyond the scope of this work to enter deeply into ancient measures; the reader is hence referred to works on ancient metrology, and more especially to Piazzi Smyth's book on the Pyramid for further information regarding Pyramidal units. The object of the foregoing digression has been simply to show that the ancients may have been capable of producing accurate, scientific, and geodetic units in very early periods of the world's history.

Between the Pyramidal epoch and the later Arab or Moslem period, several metrical systems, some of which were scientific reconstructions, and others mere rearrangements, were adopted by various nations at different times and places.

The latest of these ancient systems recorded was the Arab, or Almamun system, of the fifth or sixth century, since which time, until nearly the present,[1] the nineteenth century, not a single new scientific weight-unit appears to have been formed; while the whole of the commercial weights and measures of the world during that period apparently consisted of the débris of ancient scientific systems.

Modern scientific systems, of which there are very

[1] The kilogramme dates from 1795.

few, and these confined to Europe, are necessarily based on some existing standard units of the country.

The most perfect of these, taken generally, is the metric system of France, nominally dating from December 9, 1799, as regards the acceptance of its standards by the nation as a scientific system.

The French Metric System.

The basic unit of this system, termed the *mètre*, is a slightly enlarged half-toise, half-fathom, or yard of the old French system of commercial measures, and was at one time imagined to be the ten-millionth part of the meridian-quadrant passing through Paris, as deduced from French geodetic measurements made in 1740. Later investigation proved the incorrectness of the mètre as a geodetic unit, and thus placed it in the category of arbitrary units, the prototype or primary unit being the *mètre des archives*, made by Lenoir at Paris, in or about 1799.

The unit of surface of the metric system was the are of 100 square mètres, and the unit of cubic measure, the litre, which was nominally the 1000th part of a cubic mètre, though at a later date it lost its purely scientific and theoretical value by becoming a measure containing a kilogramme weight of distilled water at 4° Centigrade, while the measure itself was supposed to remain at the temperature of 0° Centigrade. This unfortunate departure from uniformity of temperature for the system is a most serious defect annulling practical certainty, and forcing a recourse to calculated adjustment.

The nominal basic unit of weight is the gramme, but the real unit is in actual fact the kilogramme, of 1,000 grammes, as exemplified in the *kilogramme des archives*

made at Paris about 1799, representing its legally defined value, the weight in vacuo of a cubic decimètre of distilled water at 4° Centigrade.

The scientific value of this prototype is open to much doubt ; its density cannot be directly determined from fear of damage, while the calculated weight of a cubic decimètre of water, according to Stampfer in 1830, was 999·653 grammes, and according to Kupffer in 1841 was 999·989 grammes.

The French basic units, though small compared with the cubic cubits of ancient times, thus appear to be particularly unfortunate in their practical development, both as regards geodesy and adherence to original intention in every respect. The other units of the system are, as may be seen in the subjoined table, mere decimal multiples and sub-multiples of these four basic units ; their names being well arranged with Latin and Greek affixes, so as to denote their positions in the scale.

Though decimalisation may thus be easily applied to any arbitrary units, and corresponding advantages may be obtained to a far higher degree by a more exact and accurate scientific management, the fact remains that the French and the Chinese and Japanese systems are the only ones in which it is actually carried out and fully applied at the present day.

In the period from 1812-1840, when the French *mesures usuelles* were the commercial measures used in France, the metric system formed a nearly perfect scientific system for French professional and scientific men, not only on account of its simplicity and its decimal advantages, but from its convenient relation to the commercial measures then used in France. This advantage would not accrue from the adoption of the metric system

in England for the purposes of the professional and scientific man as a purely scientific system; nor would the same advantage be obtained in any country where the ordinary commercial measures are not metric.

Excellent, then, as the metric system is, as a scientific system under certain circumstances, it would be entirely inapplicable under others; decimalisation on local or national commercial units, then, affords the only convenient alternative for the scientific and professional man in many countries, including England.

The English Scientific System.

The English scientific system, though incomplete and unpretentious, may yet be said to exist. It practically consists in a selected few of the principal commercial English units, reduced from the commercial standard temperature, 62° Fahrenheit, to the accepted scientific standard temperature, 32° Fahrenheit, thus corresponding to the metric system in this respect, and thereby obtaining the advantage of maintaining the correct connection between the units of capacity or cubic measure and the units of weight.

It may be here noticed that under the conditions applied by law to English commercial measures, which are that the units are correct at a normal temperature of 62° Fahrenheit in air under a barometric pressure of 30 inches, the important advantage of a perfect relation of weight to volume theoretically obtained in the metric system either does not exist; or if it does, is different.

This will become apparent on noticing the different values of the weight of an English cubic foot of water under different conditions according to such information as is at present available.

VALUES OF THE ENGLISH TALENT OR FOOT-WEIGHT.

At 39° Fahrenheit in vacuo, according to Miller, 'Phil. Trans.' 1856 . .	62·4245 lbs.
At 62° Fahrenheit	62·3548 lbs.
At 62° Fahrenheit, bar. 30″, the legal or commercial English value determined by Shuckburgh in 1798 . . .	62·3210 lbs.

If, too, the values of a cubic decimètre of water be considered in the same way, they are, according to Chisholm (see page 20 of his work on the 'Science of Weighing and Measuring,' London, 1877) :—

VALUES OF THE CUBIC DECIMÈTRE OF WATER.

Theoretic French value at 39° Fahrenheit in vacuo, against brass weights at 32°	1,000 grammes.
French value at 62° Fahrenheit, barometer 30″	998·717 ,,
According to the English ratio under the same conditions	998·680 ,,

The causes of this marked variety in value is not only the varying density of water at different temperature, but the loss of weight by displacement of air, which is greater in the case of water than in that of its brass counterpoise—an important consideration, as the weight of a cubic foot of air at the temperature 62° Fahrenheit with the barometer at 30″ is reputed to be 531·33 grains.

There can be little doubt that both the English commercial value of the foot-weight, determined by Shuckburgh, and the theoretic French value of the decimètre-weight are rather inaccurate, thus producing two sources of discrepancy in the comparison of French and English weight by volume ; but apart from these two

causes the alteration in the relation of weight to volume due to departure from the scientific standard temperature of comparison and from the vacuum is clearly illustrated by the above figures.

In point of fact such figures are merely computed, as it is obviously a practical impossibility to weigh a vessel of water at one fixed temperature while the water contained in it must have another fixed temperature; hence the necessity for a thorough re-investigation of the matter by scientific men, and probably too the desirability of fixing some one single temperature, perhaps that of the extreme density of water (about 39° Fahrenheit), as the single normal temperature for scientific standard purposes in Europe generally.

In the meantime, and with the object of maintaining the accepted relation with metric standards, it may be best to apply the French ratio in the English scientific measures and weights, and thus avoid one of the two above-mentioned sources of complication.

The English scientific units consist of the inch, foot, and yard, the square inch, square foot, and square yard, the cubic inch, cubic foot, and cubic yard, and the inch-weight, foot-weight, and yard-weight, with their decimal multiples and sub-multiples to any required extent; these form a complete series which, if taken at the scientific standard temperatures 32° and 39° Fahrenheit, answer most of the purposes attained by the metric system, without adopting the pecks, gallons, and pounds of the tradesman.

When it is desired to compare quantities expressed in scientific units with quantities expressed in commercial values of units of the same name, some care is necessary to avoid error or confusion. To take the single case of a

quantity expressed in inches, for instance 2 scientific inches at the temperature 32°, which has to be reduced to commercial inches at the temperature 62°. The original scientific inch when expanded to the extent afforded by this increase of temperature becomes = 1·0003 of its former value taken rigidly, hence 2 scientific inches = 2·0006 commercial inches; correspondingly also 2 commercial inches = 1·9994 scientific inches.

For all ordinary purposes, a simple percentage of reduction may be applied in such numerical reductions as follows :—

1. In linear scientific units, at 32°, 1 = 1·00029 commercial units.
2. In superficial scientific units „ 1 = 1·00057 „
3. In cubic scientific units „ 1 = 1·00086 „

Some corresponding reduction for weights at different temperatures would also be strictly necessary, were it not that the ordinary mode of comparing weight, namely, by balance, practically nearly annuls any resulting effect of temperature; the actual effect of temperature and gravity on weight is hence most frequently ignored, and an ounce at the equator is thus placed in mechanical identity with an ounce at the pole.

The values of the scientific units in metric measures are given in the table following this section; the scientific values of the furlong and mile and of the square furlong and square mile have been added to make up an obvious deficiency by the most simple means, though a further improvement as regards itinerary and land-measure may effect desirable change in the future.

The units of scientific weight have been arranged according to the best of the author's ability with the view of simple decimal systematisation.

The English Decimal Scientific Series.

Taking the three scientific units of weight at 32° Fahrenheit, the inch-weight, or weight of a cubic inch of water is about 0·578005 commercial ounce, and neither it nor its decimal multiples or sub-multiples have any simple convenient or even any approximate relation to the English commercial units of weight; this series is consequently discarded as unnecessary and is therefore omitted in the table. The corresponding weight of a cubic yard of water is about 15·04877 commercial hundredweights, and both it and its decimal multiples and sub-multiples are similarly out of accordance with commercial units, and hence are also rejected.

The weight of a cubic foot of water has, however, been a legalised standard unit of weight since the year 1859, and its legally declared value at 62° Fahrenheit, barometer 30″, was 62·3210 pounds; taking then the correct value of this unit at 32° Fahrenheit as 62·4245 pounds, or 998·79 commercial ounces, its relation to the ounce of commercial weight is tolerably well-defined and more convenient for purposes of calculation and comparison with commercial weight than any other unit that might be proposed. Denominating this foot-weight of water at 32° Fahrenheit in accordance with ancient nomenclature, it is an English *talent*, in the same way as the Greek *τάλαντον*, or talant, was the weight of a Greek or Olympic cubic foot of water.

Decimalising on this talent at intervals of 1000 (which are sufficiently small for scientific purposes, and extending the decimalisation to include every possible requirement beyond the two extremes of the com-

mercial ton and grain), the thousandth part of the English talent is 0·99879 commercial ounce, thus varying from it by only 0·12 per cent., and may hence be termed a *scientific* or a *millesimal ounce.* The thousandth part of the scientific ounce, here named a *mil*, is 0·43697 commercial grain, or about $\frac{4}{10}$ths of it ; and if a very small unit be required as is sometimes the case in monetary weight and in scientific matters, the thousandth part of the mil, termed a *doit*, is 0·000437 of a grain, or very nearly a fifth of the now obsolete English doit, which was $\frac{1}{480}$th of a grain. A unit of 1000 talents, to which the hitherto appropriated term *thousand-weight* might be applied, having a value of 27·868 tons, and just exceeding the largest known commercial unit of weight, completes this decimal series of scientific measures of weight. It is actually a *rod-weight* or weight of a cubic rod of water.

Units of Water-weight,
at 32° Fahrenheit,
based on the weight of an English cubic foot of water.

1 Rod-weight or thousand-weight	= 1000 talents or foot-weight.
1 Foot-weight or talent	= 1000 scientific ounces.
1 Scientific ounce	= 1000 mils.
1 Mil	= 1000 doits.

This small category has thus been newly arranged and put in definite form to suit professional purposes and wants until such time as the Government of the country, aided by scientific investigation, makes some move in this long-deferred matter, and completes the English scientific series in some way by permissive legal enact-

ment. It will perhaps be noticed by professional men that the advantages of the above units are :—

1. That they are based on a recognised legal unit.

2. That they are transmutable into commercial units through the ounce by a reduction of 0·12 per cent.

3. That they are purely decimal, and evenly spaced at intervals of 1000 so as to cover the requisite range.

4. That conversion from weight to volume, and from volume is practicable with them as with metric units.

5. That the actual weight of any body of known volume and density is easily ascertained. For example, the weight of two cubic feet of wrought iron, having a specific gravity of 7·78, is 15·56 talents.

6. That the reduction of units of pressure in which these weight-units are applied is as easily effected as with metric pressure-units.

Taking the English scientific system as a whole, with the addition of the decimal weight-units, it appears practical, rational, and effectual; it is, however, not yet purely decimal throughout, as the inch-units and yard-units of length, surface, and cubic measure, entering so largely into trade-matters in direct connection with professional business, cannot be entirely dispensed with for a very long time to come. When such a period does arrive, the system may be reduced to a simply decimal one based on the foot alone; but even then some new itinerary and superficial units will be required to take the place of the incongruous furlong of 220 yards, the mile of 8 furlongs, the square furlong of 10 acres or 48 400 square yards, and the square mile of 64 square furlongs or 640 acres.

At such an epoch, extended decimalisation on the

foot and square foot will probably be necessary; and the subjoined mode will probably be inevitable:—

Linear.—The foot.		
	The rod	= 10 feet.
	The chain (Ramsden's)	= 100 feet.
	The cable	= 1000 feet.
	The league	= 100 chains = 10000 feet.
Superficial.—The square foot.		
	The square rod	= 100 square feet.
	The square chain	= 10000 square feet.
	The square cable or century	= 100 square chains.
	The square league	= 10000 square chains.

Also, if the principle adopted in the weight-units be also applied to cubic units, they would become thus:—

Cubic measure.			*Corresponding water-weight units.*
1 cubic rod or mass	=	1000 cubic feet . .	The rod-weight or thousand-weight.
1 cubic foot	=	1000 fluid ounces .	The talent, or foot-weight.
1 fluid ounce	=	1000 fluid mils . .	The scientific ounce.
1 fluid mil	=	1000 fluid doits . .	The mil = 1000 doits.

The proposed league of two old London miles or 10000 feet, which is nearly 3 kilomètres, though convenient in value, is open to a slight objection as regards its name, but as the ancient English league of three miles is very nearly practically obsolete, and has long ceased to be a legal unit, any confusion arising from this cause is hardly probable, while the necessity for adopting some name indicative of itinerary measure is sufficiently evident.

When the decimalisation of the English scientific system thus becomes perfect, it will be as convenient for

the English scientific and professional man as the French metric system now is for the French scientific and professional men; and will also be in correlation with English commercial measures. There is, as far as can be ascertained, no reason for deferring the adoption of the simplified English scientific system [1] to any future time, apart from the need of a nominal retention of the inch-units and yard-units. They are hence used throughout the tables in this book.

Other Scientific Systems.

While in France a scientific system has now been long in use (since 1800), and in England a scientific system is just barely complete, in other European countries local or national scientific systems are either entirely wanting or are merely partial and incomplete, and are sometimes replaced by foreign measures, more frequently by the French metric units.

The partial and incomplete scientific systems are, however, worthy of some notice, although they should more properly be considered as mere attempts. It may be urged that almost all nations possess linear, square, and cubic measure based on some one or two units, such as a foot, or an ell or cubit, and that so far a scientific system generally exists; but the incompleteness or non-existence of a scientific system precisely consists in the absence of a series of weight-units in simple correlation with cubic units and measures of volume. Such a deficiency is due to the fact that European commercial systems of measure are mostly based on two totally independent units, one of length and one of weight.

[1] Treating it as a permissive system for technical purposes.

Two exceptional cases may be noticed, the Danish, in which the Rheinfuss is the linear unit, and the pound is $\frac{1}{62}$nd part of the cubic foot of water, and the Prussian in which the same Rheinfuss is the linear unit, and the pound is $\frac{1}{66}$th of the cubic foot of water at 15° Réaumur or 65°·7 Fahrenheit; but in neither of these cases does the ounce fall sufficiently near the 1000th part of the foot-weight of water to admit of small adjustment and the adoption of a decimal series on that basis, the Rhein foot-weight being equal to 992 Danish ounces, or to 1 056 Prussian ounces, any adjustment involving a change of nearly 1 per cent. in the former case, and of 5·6 per cent. in the latter; compared with which the present English discrepancy of about 0·12 per cent. is a trifle.

The Swedish commercial system of measures, so perfect in every respect except as regards the whole of the weights, would be capable of a superimposed scientific system only by a complete rejection of these; in that case, if a new pound $=\frac{1}{50}$th of the Swedish foot-weight of water were adopted (which would be about 523·26 grammes), a decimal series of weight-units might be formed for scientific purposes, which would then hold a most convenient correlation with local commercial measures and weights throughout.

At present there exists merely an incomplete local decimal system in Sweden. In length and distance the fot, or foot, is divided decimally, and the multiples of the fot are the stöng, or rod, of 10 feet, and the ref, or chain of 100 feet, beyond this there is a mil or league of 360 chains. In surface, the measures are the square foot, the square stöng = 100 square feet, and the square ref = 100 square stanger. In cubic measure, the cubic

foot = 1000 cubic tum, the kannar = 100 cubic tum, and the cubic ell = 4 cubic feet. In weight, there is no weight-unit in correct correspondence with cubic measure and it is in this respect that the system fails from a scientific point of view. The commercial skålpund, apparently an arbitrary unit, is the basis; its sub-multiples are the ort = $\frac{1}{100}$ skålpund, and the korn = $\frac{1}{100}$ ort; its multiples, the centner = 100 skålpund and the nylast = 100 centner; the arrangement being centesimal. The system itself is applied at the standard temperature adopted by the Swedes for commercial units, namely 15° Celsius. The centesimal subdivision, so convenient in surface measures, is a defective mode of arranging either cubic units or weight-units, which, for scientific purposes, should be arranged in strict correspondence, either decimally or millesimally.

The Russians, not possessing any distinct scientific system of their own at present, more frequently adopt French units in scientific matters; and it seems as difficult to forecast the future of Russian scientific measures as to prophesy their future internal and political development. In commercial measures, they possess a series of units Oriental or semi-Oriental by origin; these, by the order of their most practical and renowned Peter the Great, were modified slightly to be in accordance with English units, so that the Russian foot and the English foot became identical. One might imagine that the Russians would adhere to this principle in the future development and systematisation of their measures.

Since that time, however, a semi-French *régime*, accompanied with an assumption that everything French, from corsets to kilomètres, was highly civilised, has held

temporary sway in that country ; this was carried so far that most Russians of the higher classes spoke French and were comparatively ignorant of their own language ; among the lower classes the revolutionary and communistic ideas of the French became a sort of propagated gospel, taking various forms of Nihilism. At a later period these national follies were counteracted to a certain extent by German proclivities, while lastly the most recent tendency has been towards Slavonism, local and national development of the purely Slavonic branches of the Russian nation. Possibly the Finnish Ugrian and true Russian portion of the nation may, at some period, reject the Slavonic idea and take their turn at preponderance ; or perhaps the nation may revert to and stand by the principles of the time of Peter the Great. In the meantime a curious mixture of ideas seems to reign, and the same holds true in the measures, where the Oriental arsheen and sasheen exist side by side with the Anglo-Russian foot and a werst that is an approximate kilomètre, though by origin an Oriental and a Persian unit, about one seventh of a Persian farsakh.

Probably the best scientific system for the Russians would be the English decimal scientific system, based on the international foot.

Among remaining European nations a complete scientific system in correlation with local commercial measures in use seems hardly practicable.

As regards partial attempts at decimalisation and the formation of a scientific system in North-European countries, these have been generally limited. First, the substitution of a decimal inch, *tithe* or tenth of a foot, for a true duodecimal inch; thus making the subdi-

visions in square and cubic measure strictly decimal. Second, the employment of a ruthe or pole of 10 feet, so as to make the square ruthe or perch 100 square feet, and afford convenience in surveys and land-measurement, though to a very small extent. Another and an inferior alternative mode of doing this was adopted by introducing a special land-measuring foot equal to the tenth of the local ruthe or pole. Third, the berglachter or dumpflachter system adopted by mining engineers in Germany was a combination of the two last as regards principle, the unit being a lachter, klafter, or large fathom (in Prussia equal to 6⅔ feet, in Saxony equal to 7 feet, and in Bohemia 4 ells, which was decimally divided into 10 feet, 100 inches, or 1000 lines, and on this was formed a decimal system of linear, superficial, and cubic measure, distinct from ordinary commercial units, though in correlation with them. But beyond these three things decimalisation was not carried, and never extended into the units of weight, so as to form a complete decimal system. There is no doubt that not only a complete system of scientific measures might have been based on the Rheinfuss of Northern Germany and Denmark and Norway, but that a uniform commercial system for Germany might have been satisfactorily carried out on that basis, without the degradation of borrowing French measures. A sketch of such a German system, as a typical proposition, is given among the proposed systems at the end of this book.

In Southern Europe, an incomplete scientific system was adopted in the kingdom of Naples—or, more properly, the two Sicilies—in April 1840, and lasted until the unification of Italy.

The basis of this system was a geodetic mile, or miglio, equal to one minute of arc of the meridional quadrant; and the mode of subdivision was principally but not entirely decimal. The scale of linear units was thus:

1 miglio = 700 canne = 1000 passi = 7000 palmi,

and the palmo (corresponding to a foot) was 0·2646 mètre, or about 0·868 foot English; and was divided both decimally into decimi and centesimi, and duodecimally into 12 oncie, 60 minuti and 120 punti.

The scale of surface units was thus:

1 moggio = 100 square canne = 10000 square palmi,

the moggio being nearly 7·0013 ares or 0·69264 rood.

The cubic measures were:

1 cubic canna = 1000 cubic palmi,

the cubic canna being about 18·5255 cubic mètres or 653·97 cubic feet.

Beyond this, the system did not go, as apparently the old units of weight, the libbra of 320·76 grammes, the rottolo of $2\frac{7}{9}$ libbre, the cantaro piccolo of 100 libbre, and the cantaro grosso of 100 rottoli, were retained; while no new units of weight were adopted; nor, as far as present inquiry reaches, was any attempt made to form any cubicised unit of weight on the cubic palmo.

In Tuscany there were some decimalised units, based on the ordinary palmo of Florence; they were:

In length,	1 canna or pertica =	10 palmi	=	100 soldi.
In surface,	1 pertica quadrata =	100 palmi quad.	=	10000 soldi quad.
In cubicity,	1 palmo cubico	= 1000 palmi cubichi.		
In weight,	the old commercial units unmodified; the libbra, centinajo, and migliajo.			

This system was therefore both non-geodetic and incomplete, while the range of its decimalised units was exceedingly limited, not even arriving at units near either the rood or the furlong.

Such very partial attempts at scientific systematisation, though deserving notice, will not be found classified as scientific systems in the tables devoted to that branch of the subject.

The following tables give the values of the English and the French scientific units in terms of each other, and afford a means of converting quantities without need of multiplication.

The French

				French Commercial Values
Millimètre	=	0·001	mètre . .	The French commercial values are identical with the scientific values, both being arranged at freezing point. For the English commercial values, see the Metric System under Commercial Systems, pp. 317 to 319.
Centimètre	=	0·01	mètre .	
Décimètre	=	0·1	mètre .	
Mètre	=	1·	mètre .	
Décamètre	=	10·	mètres	
Hectomètre	=	100·	metres	
Kilomètre	=	1000·	mètres	
Myriamètre	=	10000·	mètres	
Centiare	=	1	mètre carré	
Déciare	=	10	mètres carrés	
Are	=	100	mètres carrés	
Hectare	=	100	ares	
Kilomètre carré	=	100	hectares	
Myriamètre carré	=	100	kilomètres carrés	
Millilitre	=	0·001	litre	
Centilitre	=	0·01	litre	
Décilitre	=	0·1	litre	
Litre	=	1	litre	
Décalitre	=	10	litres	
Hectolitre	=	100	litres	
Stère or mètre cube	=	1000	litres	
Milligramme	=	0·001	gramme	
Centigramme	=	0·01	gramme	
Décigramme	=	0·1	gramme	
Gramme	=	1·	gramme	
Décagramme	=	10	grammes	
Hectogramme	=	100	grammes	
Kilogramme	=	1000	grammes	
Myriagramme	=	10	kilogrammes	
Quintal	=	100	kilogrammes	
Millier ou tonne	=	1000	kilogrammes	

See Tables of English

System.

English Decimal Scien. Values based on the Foot at 32° Fahr.[1]	English Scientific Values in other units at 32° Fahr.
0·032809 tithe	0·039371 inch
0·328090 tithe	0·393708 inch
0·328090 foot	3·937079 inches
3·280899 feet	1·093633 yard
3·280899 rods (Ramsden)	10·936330 yards
3·280899 chains (Ramsden)	0·497106 furlong
0·328090 league	0·621382 mile
3·280899 leagues	6·213820 miles
10·764299 square feet	1·196033 sq. yard
1·076430 square rod	11·960330 sq. yards
10·764299 sq. rods (Ramsden)	119·603300 sq. yards
10·764299 sq. chains (Ramsden)	0·247114 sq. furlong
0·107630 sq. league	0·386116 sq. mile
10·764299 sq. leagues	38·611611 sq. miles
35·316581 fluid-mils	0·061027 cubic inch
353·165810 fluid-mils	0·610271 cubic inch
3·531658 fluid-ounces (milles.)	6·102705 cubic inches
35·316581 fluid-ounces (milles.)	61·027052 cubic inches
353·165810 fluid-ounces (milles.)	610·270515 cubic inches
3·531658 cubic feet	0·130802 cubic yard
35·316581 cubic feet	1·308022 cubic yard
35·316581 doits	0·000061 inch-weight
353·165810 doits	0·000610 inch-weight
3·531658 mils	0·006102 inch-weight
35·316581 mils	0·061027 inch-weight
353·165810 mils	0·610271 inch-weight
3·531658 ounces (milles.)	6·102705 inch-weight
35·316581 ounces (milles.)	61·027052 inch-weight
353·165810 ounces (milles.)	610·270515 inch-weight
3·531658 foot-weight or talents	0·130802 yard-weight
35·316581 foot-weight or talents	1·308022 yard-weight

Scientific Values.

English Decimal Scientific System; of Units based on the Foot

French

LENGTH.			**FRENCH VALUES.**	
The foot	=	10 tithes .	3·04794	décimètres
The rod	=	10 feet . .	3·04794	mètres
The Ramsden chain	=	10 rods . .	3·04794	décamètres
The cable	=	10 chains .	3·04794	hectomètres
The (decimal) league	=	100 chains or 10000 feet	3·04794	kilomètres
SURFACE.				
The sq. foot	=	100 sq. tithes .	9·28997	décim. car.
The sq. rod	=	100 sq. feet .	9·28997	mètres car.
The sq. chain	=	100 sq. rods .	9·28997	ares
The sq. cable or century	=	100 sq. chains .	9·28997	hectares
The sq. league	=	100 centuries .	9·28997	kilom. car.
CAPACITY.				
Fluid-mil	=	1000 fld.-doits .	28·31531	millim. cub.
(Millesimal) fluid-ounce	=	1000 fld.-mils .	28·31531	centim. cub.
Cubic foot	=	1000 fld.-ounces	28·31531	decim. cub.
Cubic rod	=	1000 cubic feet .	28·31531	mèt. cub.
WEIGHT.				
Mil	=	1000 doits. .	28·31531	milligrammes
(Milles.) ounce	=	1000 mil . .	28·31531	grammes
Foot-weight or talent	=	1000 ounces .	28·31531	kilogrammes
Rod-weight	=	1000 foot-weight	28·31531	milliers

This system, containing a legal unit of length, surface, capacity, and weight, under legal statute, which allows the use of decimal multiples and submultiples

alone, at Temperature 32° *Fahr. in Vacuo, with Corresponding Values.*

LENGTH.			**ENGLISH VALUES.**	
Mètre	=	10 décimètres .	3·280899	feet
Décamètre	=	10 mètres . .	3·280899	rods
Hectomètre	=	100 mètres . .	3·280899	chains
Kilomètre	=	1000 mètres . .	0·328090	league
SURFACE.				
Mètre carré	=	100 décim. carrés .	10·7643	sq. feet
Are	=	100 mètres carrés .	10·7643	sq. rods
Hectare	=	100 ares . .	10·7643	sq. chains
Kilom. carré	=	100 hectares . .	0·10764	sq. leagues
Myriam. carré	=	100 kilom. carrés .	10·7643	sq. leagues
CAPACITY.				
Millilitre		or centimètre cube . .	35·316581	fluid-mils
Litre	=	1000 millilitres .	35·316581	fluid-oz.
Mètre cube	=	1000 litres . .	35·316581	cubic feet
Kilostère	=	1000 mètres cubes .	35·316581	cubic rods
WEIGHT.				
Milligramme		. . . . . .	35·316581	doits
Gramme	=	1000 milligrammes .	35·316581	mils
Kilogramme	=	1000 grammes .	35·316581	ounces
Millier	=	1000 kilogrammes .	35·316581	foot-weights

and merely decimal multiples and submultiples of them, is doubtfully permissible applied to any unit, provided they are so mentioned.

Conversion Tables for Reducing French Values into English Scientific Equivalents at 32°.

Units	Mètres into inches	Mètres into ft., and for corr. dec. mult.	Mètres into yards
1.	39·37079	3·28090	1·09363
2.	78·74158	6·56180	2·18727
3.	118·11237	9·84270	3·28090
4.	157·48316	13·12360	4·37453
5.	196·85395	16·40450	5·46817
6.	236·22474	19·68539	6·56180
7.	275·59553	22·96629	7·65543
8.	314·96632	26·24719	8·74906
9.	354·33701	29·52809	9·84270
10.	393·70790	32·80899	10·93633

	Square mètres into square inches	Square mètres into square feet, and for corr. dec. mult.	Square mètres into square yards
1.	1550·06	10·76430	1·19603
2.	3100·12	21·52860	2·39207
3.	4650·18	32·29290	3·58810
4.	6200 24	43·05720	4·78413
5.	7750·30	53·82150	5·98017
6.	9300·35	64·58579	7·17620
7.	10850·41	75·35009	8·37223
8.	12400·47	86·11439	9·56826
9.	13950·53	96·87869	10·76430
10.	15500·59	107·64299	11·96033

	Cubic décimètres into cubic inches	Cubic décimètres into cubic feet, and for corr. dec. mult.	Cubic mètres into cubic yards
1.	61·02705	0·035317	1·30802
2.	122·05410	0·070634	2·61604
3.	183·08115	0·105950	3·92407
4.	244·10821	0·141266	5·23209
5.	305·13526	0·176583	6·54011
6.	366·16231	0·211900	7·84813
7.	427·18936	0·247216	9·15615
8.	488·21642	0·282533	10·46418
9.	549·24347	0·317849	11·77220
10.	610·27052	0·353166	13·08022
	Also for kilogrammes into inch-weight units	Also for kilogrammes into talents, or foot-weight units	Also for milliers into yard-weight units

Conversion Tables for Reducing English Scientific Values at 32° into French Values.

Units	In. into centimètres	Ft. into mètres, and for corr. dec. mult.	Yards into mètres
1.	2·539954	0·30479	0·91438
2.	5·079908	0·60959	1·82877
3.	7·619862	0·91438	2·74315
4.	10·159816	1·21918	3·65753
5.	12·699771	1·52397	4·57192
6.	15·239725	1·82876	5·48630
7.	17·779679	2·13356	6·40068
8.	20·319633	2·43835	7·31506
9.	22·859587	2·74315	8·22945
10.	25·399541	3·04794	9·14383

	Square inches into square centimètres	Square feet into square mètres, and for corr. dec. mult.	Square yards into square mètres
1.	6·45137	0·09290	0·83610
2.	12·90273	0·18580	1·67219
3.	19·35410	0·27870	2·50829
4.	25·80547	0·37160	3·34439
5.	32·25684	0·46450	4·18049
6.	38·70820	0·55740	5·01658
7.	45·15957	0·65030	5·85268
8.	51·61094	0·74320	6·68878
9.	58·06230	0·83610	7·52487
10.	64·51367	0·92900	8·36097

	Cubic inches into cubic centimètres	Cubic feet into cub. décimètres, and for corr. dec. mul.	Cubic yards into cubic mètres
1.	16·38618	28·31531	0·76451
2.	32·77235	56·63062	1·52903
3.	49·15853	84·94594	2·29354
4.	65·54470	113·26125	3·05805
5.	81·93088	141·57656	3·82257
6.	98·31706	169·89187	4·58708
7.	114·70323	198·20718	5·35159
8.	131·08941	226·52250	6·11610
9.	147·47558	254·83781	6·88062
10.	163·86176	283·15312	7·64513
	Also for inch-weight units into grammes	Also for foot-weight units into kilogrammes	Also for yard-weight units into millier

The English Decimal Scientific System, at 32°

Scientific Units			Commercial Values
Length.			
The foot	=	10 tithes .	. 1·00029 feet
The rod	=	10 feet .	. 3·33430 yards
The chain	=	100 feet .	. 6·06236 poles
The cable	=	1000 feet .	. 0·15156 furlong
The decimal league	=	10000 feet .	. 1·89449 miles
Surface.			
The sq. foot	=	100 sq. tithes	. 1·00057 sq. feet
The sq. rod	=	100 sq. feet	. 0·36752 sq. poles
The sq. chain	=	10000 sq. feet	. 0·91880 rood
The sq. cable or century	=	100 sq. chains	. 22·96991 acres
The sq. league	=	10000 sq. chains	. 3·58905 sq. miles
Capacity.			
Fluid-mil	=	1000 fluid-doits	. 2·07804 minims
Fluid-ounce	=	1000 fluid-mils	. 0·99746 fluid-oz. 1·72903 cub. inch
Cubic foot	=	1000 fluid-oz.	. 1·00086 cub. feet 6·2344 gallons
Cubic rod	=	1000 cubic feet	. 37·06892 cub. yards
Weight.			
Mil	=	1000 doits .	. 0·43697 grain
Ounce	=	1000 mils .	. 0·99879 ounce
Foot-weight or talent	=	1000 ounces	62·42454 pounds 1·00166 foot-weight
Rod-weight	=	1000 foot-weight	27·86810 tons

The reduction from and to scientific units merely consists in reduction foı cimalisation of the ounce ; these unite to form the cubicity of the decimal In calculations the reductions can be effected by conversion into foot-units

Fahr., compared with English Commercial Values at 62°.

Commercial Units				Scientific Values
LENGTH				
Foot	=	12 inches	. .	0·99971 foot
Yard	=	3 feet	. .	2·99913 feet
Pole	=	$5\frac{1}{2}$ yards	. .	1·64952 rod
Furlong	=	40 poles	. .	6·59809 chains
Mile	=	8 furlongs	. .	0·52785 league
SURFACE.				
Square foot	=	144 sq. inches	.	0·99943 sq. foot
Square yard	=	9 sq. feet	. .	8·99487 sq. feet
Square pole	=	$30\frac{1}{4}$ sq. yards	.	2·72095 sq. rod
Rood	=	40 sq. poles	. .	1·08838 sq. chain
Acre	=	4 roods	. .	4·35352 sq. chains
Square furlong	=	10 acres	. .	43·53517 sq. chains
Square mile	=	64 sq. furlongs	.	0·27863 sq. leagues
CAPACITY.				
Cubic inch	.	. . . .	.	0·57821 fluid-ounce
Cubic foot	=	1728 cub. inches	.	0·99914 cubic foot
Fluid ounce	=	480 minims	. .	1·00254 fluid-ounce
Gallon	=	160 fld.-ounces		160·40606 fluid-ounces
Bushel	=	8 gallons	. .	1·28325 cubic feet
Quarter	=	8 bushels	. .	10·26599 cubic feet
WEIGHT.				
Grain	.	. . . .	.	2·28848 mils
Ounce	=	437·5 grains	.	1·00121 ounce
Pound	=	16 ounces	.	16·01934 ounces
Foot-weight	=	62·3210 pounds	.	0·99834 foot-weight
Hundredweight	=	112 pounds	.	1·79417 foot-weight
Ton	=	20 cwt.	.	35·88322 foot-weights

temperature, change of standard, and the slight modification due to exact de-
scientific system, as in the French system at 32°.
and application of a percentage.

COMPOUND UNITS.

The foregoing systems of all sorts, whether commercial or scientific, have been hitherto dealt with merely as systems composed of simple units ; it will be evident, however, that well-arranged systems can only be perfect when they afford convenient compound as well as simple units, and that resulting compound units thus form an important test of a system.

In commercial systems, the principal tests of convenience are, that a unit shall be forthcoming at any part of the series where trade, or any branch of trade, demands it as necessary ; that these units shall be taken as estimated in air at some mean temperature well suited to the country ; that the mode of subdivision shall be in accordance with the habits or forms of thought of the people, either binary or decimal, or a combination of the two ; and that the framework or skeleton of the commercial system shall be thoroughly systematised on scientific principles.

For a scientific system, the principal tests are that it shall be complete and convenient for all scientific and professional purposes, that the units shall be very exactly defined and easily recoverable, that the correspondence or connection between any two units in the system, however far apart or different in kind, shall be exceedingly simple and arranged on a decimal basis ; also that the system shall be in some convenient accordance with the commercial measures of the country.

The extent to which the English commercial system and the just-completed English scientific system ap-

proximate to these conditions has been a subject frequently referred to in the foregoing chapters.

Compound units, however, require a higher amount of simplicity than simple units, as their nature renders them more difficult to manipulate or calculate. Generally speaking, they are regarded as scientific units, and hence should form part of a scientific system; frequently however, they are taken as commercial units, even when having but slight connection with commercial matters.

Strictly speaking, and taking matters as they should be rather than as they are, the commercial compound units are units compounded of monetary and commercial simple units, while scientific compound units should include all technical compound units and be calculated and dealt with as parts of a scientific system.

The most common type of compound unit is purely commercial, being compounded of a commercial and a monetary unit, and taking the forms, £1 per acre, 1 shilling per gallon, 1 penny a pound, and so forth. Now, though coinage and monetary matters generally are beyond the scope of this book, yet when compound units of the above type are so important, it becomes necessary to take moneys of account into consideration.

The following list of the moneys of account and modes of subdivision used in various countries, with their nominal values at par in English money and in Canadian dollars, may be useful for reference, while considering the effect of compounding commercial and monetary units in foreign transactions.

MONEY OF ACCOUNT

USED IN VARIOUS COUNTRIES.

	Nominal Values at par			
	$	£	s.	d.
EUROPE :—				
England and English Colonies: the pound = 20 shillings	4·80	1		
the shilling = 12 pence	0·24		1	
the penny = 4 farthings	0·02			1
France and French Colonies: the franc = 100 centimes	0·19			$9\frac{1}{2}$
the centime	0·0019			0·095
German Empire : reichsmark = 100 pfennige	0·24		1	
pfennige	0·0024			0·12
Denmark : the kronor = 100 öre	0·2666		1	$1\frac{1}{3}$
ore	0·0027			0·133
Sweden : the riksdaler = 100 öre	0·2666		1	$1\frac{1}{3}$
ore	0·0027			0·133
Norway : Specie-daler = 4 kronor	0·2666		1	$1\frac{1}{3}$
kronor = 100 öre	0·0027			0·133
Holland and Colonies, Java, Surinam: guilder = 100 cents	0·40		1	8
cent	0·0040			0·2
Belgium : franc = 100 centimes	0·19			$9\frac{1}{2}$
centime	0·0019			0·095
Switzerland : franc = 100 rappen	0·19			$9\frac{1}{2}$
rap or centime	0·0019			0·095
Austro-Hungarian Empire : gulden = 100 kreutzer	0·47		1	$11\frac{1}{2}$
kreutzer	0·0047			0·235
Russia : silver ruble = 100 copek	0·76		3	2
copek	0·0076			0·38
Spain : peseta = 100 centimos	0·19			$9\frac{1}{2}$
centimo	0·0019			0·095
Gibraltar : duro = 20 reals	0·98		4	1
real = 10 decimas	0·0490			2·45
Portugal : milrei = 1000 reis	1·0667		4	$5\frac{1}{3}$
rei	0·0011			0·053
Italy : lira = 100 centimes	0·19			$9\frac{1}{2}$
centime	0·0019			0·095
Malta : scudo = 12 tari	0·40		1	8
taro = 2 carlini	0·0333			$1\frac{2}{3}$
carlino = 10 grani	·0167			0·633
Turkey : lira turca = 100 piastres	4·32		18	0
piastre = 40 paras	0 0432			2·16
Greece : drachma = 100 lepta	0·19			$9\frac{1}{2}$
lepton	0·0019			0·095
AFRICA :—				
Egypt : piastre = 40 fuddah	0·05			$2\frac{1}{2}$
fuddah	0·0013			$\frac{1}{16}$
Abyssinia : pataka, or old Austrian thaler = 23 harf	1		4	2
harf = 4 divani	0·0435			$2\frac{4}{23}$
Tripoli : mahbub = 20 piastres	1		4	2

MONEY OF ACCOUNT—*continued.*

	Nominal Values at par $	£ s.	d.
AFRICA—*continued.*			
piastre = 40 para	0·05		$2\frac{1}{2}$
para	0·0013		$\frac{1}{16}$
Tunis : piastre = 16 karub	0·1167		$5\frac{5}{6}$
karub	0·0073		$\frac{35}{96}$
Morocco : mitkal = 10 wakia	0·74	3	1
waki = 4 blankil	0·0740		3·7
blankil	0·0185		0·925
ASIA :—			
Arabia : piastre = 80 kavir	0·82	3	5
kavir	0·0103		$\frac{1}{2}$
Persia : toman = 10 keran	2·230	9	$3\frac{1}{2}$
keran = 20 shahi	0·1115		$11\frac{1}{4}$
shahi = 50 dinar	0·0056		$\frac{5}{8}$
India : rupi = 16 anna	0·48	2	0
anna = 12 pai	0·03		$1\frac{1}{2}$
pai	0·0025		$\frac{1}{8}$
Ceylon : Rupi = 100 cents	0·48	2	0
cent	0·0048		0·24
Burma : tikal, or kyat = 8 mus	0·48	2	0
mus = 2 bai	0·06		3
bai = 8 rewh	0·03		$1\frac{1}{2}$
Siam : tikal, or bat = 4 miam	0·60	2	6
miam = 2 fuan	0·15		$7\frac{1}{2}$
fuan = 4 fainun	0·07		$3\frac{3}{4}$
Anam : quan = 10 mas	0·6667	2	$9\frac{1}{3}$
mas = 60 cash	0·0667		$3\frac{1}{3}$
Philippines and Borneo : peso = 20 reals	1	4	2
real = 100 cents	0·01		$2\frac{1}{2}$
China : liang = 10 tsin	1·40	5	10
tsin = 10 fan	0·14		7
fan = 10 li	0·0140		0·7
Japan : yen = 100 sen	1	4	2
sen = 10 rin	0·01		$\frac{1}{2}$
AMERICA :—			
Dominion of Canada : dollar = 100 cents	1	4	2
cent	0·01		$\frac{1}{2}$
United States : dollar = 100 cents	0·9863	4	$1\frac{5}{16}$
cent	0·0099		$\frac{1}{2}$
Central America :—			
Mexico : dollar = 100 cents	1	4	2
Guatemala, Nicaragua, Honduras, Costa Rica, Spanish Antilles } dollar = 100 centavos	0·96	4	0

MONEY OF ACCOUNT—*continued.*

South America :—	Nominal Values at par $	£ s. d.
Colombia : peso, or fuerte = 100 centavos	0·96	4 0
Venezuela : peso, or old Prussian thaler = 100 centavos	0·72	3 0
British Guiana : dollar = 100 cents	1	4 2
Ecuador : peso = 100 centavos	0·96	4 0
Peru : sol = 100 centesimos	0·96	4 0
Bolivia : peso = 100 centenas	0·74	3 1
Chili : peso = 100 centavos	0·90	3 9
Buenos Ayres : patacon = 100 centesimos	0·96	4 0
Uruguay, Paraguay } peso = 100 centimes	0·96	4 0
Brazil : milreis = 1000 reis	0·54	2 3

At some places and countries in Asia and Africa, where there is no established money account, the precious metals, whether coined or not, or in the form of gold-dust, are estimated by weight : thus, weight-units and their subdivision take the place of monetary units and subdivision, in dealing with compound commercial units.

An examination of this list shows the general prevalence of decimalised moneys of account, and as it may be accepted as a principle that compound units are more simple in calculation when the two units from which they are compounded are similar in mode of subdivision, the conclusion becomes inevitable that for purposes of foreign trade generally, decimalisation is the most convenient method for arranging compound units.

It is on this basis that the decimalisation of all commercial measures has been strenuously advocated ; but while granting the correctness of the basis, it may be noticed that it also affords a strong argument against the decimalisation of English commercial measures, until the English money of account is decimalised.

On the same basis also the general adoption of French commercial measures has been urged ; if, however, there is any advantage in that, it would only

be when adopting the French monetary system also.

There is a very wide distinction between decimalising English measures and English money and adopting French measures and French money; but whatever opinions may be held as to the advisability of either mode, it seems an inevitable conclusion that the measures and the money should be of the same sort. When the preponderance of commerce is French, it may become advisable to adopt French measures and monetary units in foreign trade; until that time it is certainly unnecessary, while for purposes of home-trade it would be a mischievous innovation.

The decimalisation of English commercial measures and money together may be advisable; but this seems a matter open to much doubt; probably the rectification, improvement, and simplification of the commercial measures through small changes, not exceeding fluctuation due to change of temperature, and their rearrangement on a decimal framework, such as that of the English scientific system already described, would serve every required purpose and pressing need at present. The compound units and calculations of cost in connection with foreign trade would, as hitherto, be carried out by clerks and others conversant with the business; and as far as personal injury goes, neither the number of clerks employed nor the amount of trade done would be much affected under any system of measures and moneys of account.

Should at any time decimalisation become inevitable in both English commercial measures and monetary units, the decimalised framework of the commercial system comprised in the English scientific decimal series can

then serve the requirements of the case, with but few additional units; and the monetary decimalisation will be most conveniently effected by slightly altering the copper money, making the penny $\frac{1}{250}$th of the pound, and the farthing $\frac{1}{1000}$th of the pound, without altering the gold or the silver money in any way.

The principal inconvenience in this latter plan is that $12\frac{1}{2}$ pence would go to a shilling, and that a half-shilling would no longer be called sixpence [1]; but any other mode of effecting monetary decimalisation in England would be more subversive in effect. The arrangement proposed, being millesimal, has also some advantages over a centesimal subdivision.

Proceeding to compound units of another sort; the principal of these are Pressure-units, Irrigation-units and Water-supply-units, Power-units, Heat-units, and Electro-magnetic-units. Most of these are dealt with entirely by technical, professional, and scientific men, and hence should fall entirely in a scientific series or system, although in England hitherto this has not been possible owing to the want of fixity and completeness of any distinct scientific system

Pressure-units.—Taking the pressure-units first in order, those ordinarily used in England, the pound per square inch, the pound per square foot, and the ton per square inch. Adopting the simple units at the commercial or normal standard temperature, 62° Fahrenheit in air, the compound units are thus compared with French compound units:—

Since 1 pound = 0·453 593 kilog.; and 1 square inch = 6·447 68 cent. car.; hence 1 lb. per sq. inch = 0·070 3498 kilog. per cent. car.

[1] Perhaps the term tester, testoon, or some other old name could be re-applied.

In the same way also—

1 lb. per sq. foot = 4·885 403 kilog. per cent. car.
1 ton per sq. inch = 1·57583 quintals per cent. car.

Conversely also in the reduction of French compound units to English values on the commercial scale;

Since 1 kilogramme = 2·20462 lbs.; and 1 centimètre car. = 0·15509 square inch; hence 1 kilog. per centim. car. = 14·21468 lbs. per sq. inch.

In the same way also—

1 kilog. per mètre car. = 0·204692 lbs. per sq. foot.
1 millier per cent. carré = 6·34587 tons per sq. inch.
1 quintal per mètre car. = 0·182761 cwt. per square foot.

The reduction and manipulation of such quantities and units is evidently troublesome and inconvenient.

If, however, the English units of the decimal scientific system at 32° be applied to form compound units of pressure, the calculation is not only more simple, but requires merely the movement of the decimal point in the values of the simple units.

In compound units of this system, it is preferable to use the term *talent* instead of *foot-weight*, so as to avoid much repetition of the word *foot* in the combined terms; but this not often of great consequence.

Using the foot-weight and the square foot, it is thus effected;

Since 1 foot-weight = 28·315 312 kilogrammes, and 1 square foot = 0·092 899 68 mètre carré; hence 1 foot-weight per sq. ft. = 304·7945 kilog. per mèt. car. Also, 1 foot-weight per square foot = 0·304 7945 milliers per mètre car.

And this corresponds to the metric value of the linear foot, at the scientific standard, which is 0·304 7945 mètre.

In the same way also—

1 foot-weight per sq. foot = 0·030 479 45 kilog. per cent. car.

1 rod-weight per sq. foot = 304·7945 milliers per mètre car.

And conversely also—

1 kilogramme per mètre carré = 0·003 280 899 foot-weight per sq. foot.

1 millier per mètre carré = 3·280 899 foot-weight per sq. foot;

where the values correspond to that of the linear mètre, as regards figures apart from their decimal position, the latter being 3·280 899 feet of the scientific system.

The figures can thus be taken in all cases of pressure-units from the values of simple linear units of the scientific system, given in the preceding chapter; and there is no need of special tables, or of troublesome reduction.

Pressure is frequently estimated in simple, in preference to compound, units; in that case the unit adopted is the theoretical pressure of one atmosphere. Its values expressed in other terms are thus—

1 atmosphere = 14·71 lbs. per sq. inch = 1·033 kilog. per cent. car.

Its equivalents in counterbalancing water column and mercurial column are—

1 atmosphere = 33·9 ft. of water = 10·33 mèt. of water.

" " " = 2·5 feet of mercury = 76 centimètres of mercury.

Irrigation-units.—Treating irrigation-units in the same manner as the compound units of pressure, and using the English commercial units, such as cubic feet of water per acre irrigated :

Since 1 cubic foot = 0·028 291 mètre cube ; and 1 acre = 0·404 440 hectare ;

Hence 1 cubic foot per acre = 0·069 951 mètre cube per hectare.

Conversely also—

1 mètre cube per hectare = 14·2958 cubic feet per acre.

But if the English scientific units are used at 32° Fahr., the cubic foot and the square chain, or the century :

Since 1 cubic foot = 0·028 3153 mètre cube ; and 1 square chain = 0·092 8997 hectare ;

Hence 1 cubic foot per sq. chain = 0·304 7945 mètre cube per hectare ; and 1 cubic rod per century = 3·047 945 mètres cubes per hectare.

Conversely also—

1 mèt. cube per hectare = 3·280 899 cub. ft. per sq. chain.

" " " " = 0·328 090 cubic rods per century.

The figures in each case being those of values of the linear units, the foot and the mètre.

Irrigation is also sometimes estimated in simple in preference to compound units ; in that case the unit

adopted is the linear unit of depth of water when the irrigation is theoretically spread over, or is standing on a surface.

1 foot of standing water = 10 000 cubic feet per sq. chain.

0·1 foot of standing water = 10 cubic feet per century.

" " " " " = 0·030 479 mètre cub. per hectare.

And

1 décimètre of standing water = 1000 mèt. cub. per hectare.

" " " " " = 328·090 cubic rods per century.

Water-supply-units.—These, being units of continuous supply, are irrigation-units, compounded with time-units; the *second* being the time-unit most commonly adopted both by the English and French.

With commercial units, then—

1 cub. ft. per second per acre = 0·069 951 mèt. cub. per sec. per hectare.

1 mèt. cub. per second per hectare = 14·2958 cub. ft. per sec. per acre.

And with scientific units—

1 cub. ft. per sec. per sq. chain—0·304 79 mèt. cub. per sec. per hectare.

1 mèt. cub. per sec. per hectare = 3·2809 cub. ft. per sec. per sq. chain.

Power-units and Units of Work.—The ordinary English power-units on the commercial scale at 62° Fahr. are the foot-pound and the horse-power; the

French corresponding units on the scientific scale at 32° Fahr. are the kilogrammètre and the *force de cheval.*

The relation is as follows—

1 foot	=0·304708	mètre.
1 pound	=0·453593	kilogramme.
1 foot-pound	=0·1382134	kilogramme-mètre.

Conversely also—

1 kilogrammètre=7·235187 foot-pounds.

The English horse-power is 33000 lbs. raised 1 foot in one minute, or 550 foot-pounds per second ; the French *force de cheval*, or *cheval-vapeur* is 4500 kilogrammètres per minute, or 75 kilogrammètres per second.

Hence

1 H.-P. English=33000 foot-pounds=4561·0422 kilog.-mètres per minute.
" " " =1·0135649 C.-V. French.

And

1 cheval-vapeur = 4500 kilog.-mètres = 32558·3415 foot-pounds per minute.
" " " =0·9866164 H.-P. English.

In applying English decimal and scientific units at 32° Fahr. in compound units of this class, it may be noticed that as the standard value of the ounce is slightly altered, the millesimal ounce being 0·99879 of a commercial ounce, there may be two modes of obtaining the compound unit, one by reduction and forming an exactly equivalent unit in other terms, the other by simple substitution of the millesimal ounce for the commercial ounce, and thus slightly varying the absolute value of the compound unit.

The latter method is to be preferred, from the advantage of adherence to round numbers.

Next, as the pound does not exist in the decimal series, either the foot-weight, here more conveniently termed a talent, or the millesimal ounce must be adopted. Adopting the talent, the new compound unit will be the foot-talent ; then

1 foot = 0·304 7945 mètre.
1 talent = 28·315 312 kilogrammes.
Hence 1 foot-talent = 8·630 3504 kilogrammètres.

And conversely—

1 kilogrammètre = 0·115870 foot-talents.

Hence also—

1 cheval-vapeur = 4500 kilog.-mètres per minute.
" " " = 521·4150 foot-talents per minute.

Adopting also the slightly modified value of the English H.-P. unit, instead of being 528000 foot-ounces of the commercial ounce, it becomes 528000 foot-ounces of the millesimal ounce in the scientific series.

Hence 1 H.-P. = 528 foot-talents exactly per minute.
= 4556·825 kilogrammètres.
= 1·012 6277 cheval-vapeur.

Conversely 1 cheval-vapeur = 3·9875284 H.-P. of this sort.

While thus keeping as close to the old value of the English H.-P. unit as is possible with corresponding numbers on the scientific scale, no very important alteration is effected, as the change is less than one-tenth per cent., being 0·0009.

It may, however, be noticed that this theoretical

horse-power unit would be much more convenient, if entirely altered in value, so as to be in more simple ratio to the lower units and the whole scale of scientific units ; 600 foot-talents per minute or 10 foot-talents per second would be a much more convenient value for English H.-P.

Thermal and Electro-magnetic units.—The units adopted in calculations involving heat, thermal equivalents, mechanical equivalents of heat, and calculations of quantity and current, are frequently very complicated and require logarithmic computation. Most of the units involve the foot-grain in English, and the mètre-gramme in French measure, and the second is the unit of time with both.

Taking the commercial values of these—

The foot-grain $= 0{\cdot}30471 \times 0{\cdot}0648 = \left\{ \begin{array}{l} 0{\cdot}01974 \text{ mèt.-} \\ \text{gramme.} \end{array} \right.$

The mètre-gramme $= 3{\cdot}2818 \times 15{\cdot}4323 = \left\{ \begin{array}{l} 50{\cdot}6464 \text{ foot-} \\ \text{grains.} \end{array} \right.$

For purposes of this description in scientific units the mil, $\frac{1}{1000}$th of the millesimal ounce, would be the unit to replace the grain, being somewhere about half of it, or 0·43697 grain ; and the new compound scientific unit would be the foot-mil, so that—

1 foot-mil $= 0{\cdot}30479 \times 0{\cdot}028315 = 0{\cdot}00863035$ mètre-gramme.

1 mètre-gramme $= 3{\cdot}2809 \times 35{\cdot}3166 = 115{\cdot}870$ foot-mils.

The change effected by the adoption of these units would run through the whole system of thermal and magnetic quantities and equivalents; but it would certainly be an advantage, on the whole, to carry out the

English decimal scientific system in every branch of scientific work, and thus to become perfectly independent of French terms and units, while obtaining all the advantages of decimalisation and simple systematisation. At some future period it may be hoped that the whole series of English scientific units may be arranged to a single temperature; but at present, and as long as the French adopt two temperatures in their system, the advantages of exact correlation in this respect, and easy interchange of scientific results with exactitude, perhaps counterbalance that of adopting a single standard temperature.

COMPOUND UNITS.

At the English Commercial Standard, Temp. 62°, Bar. 30″.

Pressure.		*Commercial Equivalents.*
1 pound per square inch	=	0·070 3498 kilog. per centim. carré
1 ,, ,, foot	=	4·885 40 kilog. per mètre carré
1 cwt. ,, ,,	=	5·471 645 quintals per mètre carré
1 ton ,, inch	=	0·157 583 milliers per centim. carré

1 kilogramme per centim. carré	=	14·21468 pounds per square inch
1 ,, mètre ,,	=	0·204692 ,, ,, foot
1 millier ,, ,,	=	1·82761 cwt. per ,, ,,
1 ,, per centim. ,,	=	6·34587 tons per ,, inch

Irrigation.		*Commercial Equivalents.*
1 cubic foot per acre	=	0·069 951 mètre cube per hectare
1 ,, ,, rood	=	0·279 804 ,, ,, ,,

1 mètre cube per hectare	=	14·2958 cubic feet per acre
1 ,, ,,	=	3·57395 ,, ,, rood

Power and Work.		*Commercial Equivalents.*
1 foot-pound	=	0·138 2134 kilogrammètres
1 h.-p. = 33000 ft.-lbs. per min.	=	1·013 5649 force de cheval, c.-v.

1 kilogrammètre	=	7·235 187 foot-pounds
1 c.-v., or force de cheval (4500)	=	0·986 6164 h.p., horse-power

Heat and Electro-magnetism.		*Commercial Equivalents.*
1 foot-grain	–	0·019 7448 mètre-grammes

1 mètre-gramme	=	50·6464 foot-grains

Units of Reduction.

The units of reduction required with the English commercial equivalents are hence many and diverse; the preferable mode is to use the following scientific equivalents, which involve only four units of reduction and their reciprocals apart from the position of the decimal point.

COMPOUND UNITS.

At the English Scientific Standard, Temp. 32° Fahr. in vacuo.

PRESSURE. *Scientific Equivalents.*

1 talent (or foot-weight) per sq. foot.	=	304·7945 kilog. per mèt. car.
,, ,, ,,	=	0·030 47945 kilog. per cent. car.
,, ,, ,,	=	0·304 7945 milliers per mèt. car.
1 rod-weight per square foot .	=	304·7945 milliers per mèt. car.

1 kilogramme per mètre carré .	=	0·003 2809 talents per sq. foot
1 kilogramme per centim. carré .	=	0·328 0899 talents per sq. tithe
1 millier per mètre carré . .	=	3·280 899 talents per sq. foot
1 millier per centim. carré . .	=	32·808 990 rod-weight per sq. foot

IRRIGATION. *Scientific Equivalents.*

1 cubic foot per square chain .	=	0·304 7945 mèt. cub. per hectare
1 cubic foot per century . .	=	0·003 0479 mèt. cub. per hectare
1 cubic rod per century . .	=	3·047 945 mèt. cub. per hectare

1 mètre cube per hectare . .	=	3·280 899 cubic feet per sq. chain
,, ,, . .	=	328·089 9 cubic feet per century
,, ,, . .	=	0·328 090 cubic rods per century

POWER AND WORK. *Scientific Equivalents.*

1 foot-talent	=	8·630 3542 kilogrammètres
1 h-p. = 528 ft.-talents per min.	=	1·012 63 c-v. force de cheval

1 kilogrammètre	=	0·115 870 foot-talents
1 c-v. force de cheval (4500)	=	0·987 528 h-p. (scientific)

HEAT AND ELECTRO-MAGNETISM. *Scientific Equivalents.*

1 foot-mil	=	0·008 63035 mètre-grammes

1 mètre-gramme	=	115·870 154 foot-mils

UNITS OF REDUCTION.

English into French		French into English	
Simple . .	0·304 794 494	Simple . . .	3·280 8992
Square . .	0·092 899 683	Square . . .	10·764 2993
Cubic . . .	0·028 315 312	Cubic . . .	35·316 5807
Fourth power .	0·008 630 354	Fourth power . .	115·870 1450

CONSTANTS, CORRECTIONS, AND QUANTITIES

Used in connection with Standards.

Comparison of Standard Temperatures on Various Scales.

	Fahr. °	Cent. °	Réau. °
Former English normal temperature	30	−1·11	−0·89
Temperature of melting ice French commercial and scientific normal English scientific normal	32	0	0
English temperature for max. density of water	39·1	3·945	3·156
French temperature for max. density of water	39·2	4	3·2
Hassler's temperature for max. density of water	39·83	4·35	3·48
Mean atmospheric temperature in connection with barom. pressure	50	10	8
Former French temperature of comparison	54·5	12·5	10
Swedish normal commercial temperature	59	15	12
Former French normal, for the toise de Pérou	61·25	16·25	13
English normal commercial temperature, since 1872 generally; since 1824 partially	62	16·66	13·33
Prussian normal commercial temperature	65·75	18·75	15
Normal temperature for Thaï (Siam)	85	29·44	23·556

Compensating Temperatures for verifying Measures of Capacity by the weight of water contained.

	°	°	°
For a Litre Measure, according to Van der Toorn.			
Glass vessel	45	7·22	5·8
Copper ,,	51·8	11·00	8·8
Brass ,,	52·8	11·56	9·24
Pewter , 5 tin to 1 lead	56·3	13·50	10·88
For English Commercial Measures Standards Department, applicable to the gallon.			
Glass vessel	50	10	8
Brass ,,	57·4	14·1	11·83

DENSITY AND EXPANSION.

Mean Densities of materials used in Standard measures.

At temp. 62° Fahr.		At temp. 32° Fahr.	
Platinum	21·1572	Pure platinum	21·402
Brass	8·1430	Annealed platinum	21·326
Bronze gilt	8·2829	Pure iridium	22·194
Iron adjusted with lead	7·1270	Platinum-iridium of $\frac{1}{10}$ iridium	21·449
Quartz	2·6505	Ditto annealed	21·429
Glass	2·5179	Brass	8·0298
Water	0·9988834	Gun-metal	8·4947

Ordinary mean densities of metals, accepted.

Brass, 3 copper to 1 zinc	8·435	Copper	8·85
Gun-metal, 9 copper to 1 tin	8·694	Zinc	7·19
Bailey's metal, 16 copper, 2½ tin, 1 zinc	8·554	Tin	7·29
Nickel	8·670	Iron (cast)	7·00
Wrought iron	7·750	Steel	8·00

Mean densities of grain.

Wheat	0·76	Rye	0·69	Rice	0·80
Barley	0·63	Buckwheat	0·68	Peas, lentils	0·80
Linseed	0·64	Millet	0·68	Maize	0·60
Colza	0·66	Oats	0·44	Hemp	0·52

Table of Linear Expansion of Metal Bars between temperatures of 36° *and* 79° *Fahr. applicable to any linear unit.*

	For 1° Fahr.	For 30° Fahr.	For 1° Cent.	For 15° Cent.
Platinum	0·000 00476	0·000 1428	0·000 00857	0·000 1285
Brass	0·000 00956	0·000 2870	0·000 01721	0·000 2581
Bronze	0·000 00947	0·000 2841	0·000 01705	0·000 2557
Copper	0·000 00873	0·000 2618	0·000 01571	0·000 2357
Wrought iron	0·000 00550	0·000 1650	0·000 00990	0·000 1485
Cast iron	0·000 00611	0·000 1833	0·000 01100	0·000 1650
Cast steel	0·000 00575	0·000 1725	0·000 01035	0·000 1553
Glass	0·000 00492	0·000 1477	0·000 00886	0·000 1328
Pinewood	0·000 00275	0·000 0827	0·000 00495	0·000 0743

Table of Cubic Expansion.

	For 1° Fahr.	For 1° Cent.
Platinum-iridium	0·000 01428	0·000 02570
Brass	0·000 02870	0·000 05166
Glass	0·000 01476	0·000 02658
Mercur	0·000 0998	0·000 17971
Dry air	0·000 2031	0·000 36560

WEIGHT OF AIR.

Observed values of the weight of a Litre of dry air.

Observer.	Place.	Latitude.	Height.	Weight in grammes.
Regnault.	Paris.	48° 50′ 14″	60m	1·293 496
Miller.	Cambridge.	50° 12′ 18″	8m	1·293 893
Lasch.	Paris.	48° 50′ 14″	60m	1·293 204
	Berlin.	52° 30′ 0′	40m	1·293 880
Calculated for mean position		45°	0m	1·293 030

Formula for calculating the weight of a Litre of dry air at any place.

W = weight in grammes at 0° Centigrade, barom. 760 mm.
h = height of place above mean sea level.
L = latitude.
R = terrestrial radius = 6·366198 mètres.

$$\text{Then } W = 1{\cdot}293\,0693 \left(1 - 1{\cdot}32\frac{h}{R}\right)(1 - 0{\cdot}002\,5659 \cos 2L).$$

Table of Corrections for applying to the mean value 1·29303 *for other heights and latitudes, at* 0° *Cent., bar.* 760 *mm.*

Lat.	h = 0m	50m	100m	150m	200m	250m
40°	−0·00058	59	60	62	63	64
41°	−0·00046	48	49	50	52	53
42°	−0·00035	36	37	39	40	41
43°	−0·00023	25	26	27	29	30
44°	−0·00012	13	14	16	17	18
45°	−0·00000	01	03	04	05	07
46°	+0·00012	10	09	08	06	05
47°	+0·00023	22	21	19	18	17
48°	+0·00035	33	32	31	29	28
49°	+0·00046	45	43	42	41	39
50°	+0·00058	56	55	54	52	51
51°	+0·00069	68	66	65	64	62
52°	+0·00080	79	77	76	75	74
53°	+0·00091	90	89	87	86	85
54°	+0·00102	01	00	98	97	96
55°	+0·00113	12	11	09	08	07

Having thus obtained a value (W) at 0° Cent. and 760 mm. bar., allowance may be made for any other temperature (t° Cent.) between 0° and 50° Cent.; also for pressure of vapour (v) present, and barometric pressure (b), both in millimetres of mercury at 0° Cent., by the following formula :—

$$\text{Corrected value} = \frac{W\,.\,(b - 0{\cdot}378\,v)}{(1 + 0{\cdot}003656\,t^\circ)\,.\,760}$$

WEIGHT OF AIR—*continued.*

Weight of air displaced by Standard Kilogrammes of various materials at temp. $16\frac{2}{3}°$ *Cent., barom.* 761·986 *mm.*

	Density.	Weight of air displaced in milligrammes.
French platinum	20·5487	59·25
English platinum	21·1379	57·60
French brass	8·2063	151·75
English bronze gilt	8·3291	146·23
,, iron adjusted with lead	7·1270	170·84
,, quartz	2·6505	459·32

Weight of air that would be displaced by Standard Foot-weights (or Talents) of various materials, at temp. 62° *Fahr., barom.* 30 *inches.*

	Density.	Weight of air displaced in English mils.
Platinum	21·1572	57·476
Brass	8·1430	149·324
Bronze gilt	8·2829	146·757
Iron adjusted with lead	7·1270	170·575
Quartz	2·6505	458·812
Glass	2·5179	482·772

The allowance to be applied for other temperatures and pressures.

For 10° Fahr. less, deduct 2·12 per cent.; for 1″ bar. less, deduct 3·34 per cent.

For 10° Cent. less, deduct 3·82 per cent.; for 10 mm. bar. less, deduct 1·31 per cent.

English and French Values.

At Westminster.	At 62° Fahr. foot-wt.	At 32° Fahr. foot-wt.
Weight of 1 cubic foot of dry air, bar. 30″	0·001 215	0·001 294
Weight of a talent or foot-weight of water on the scientific scale	1·001 657	1
Weight of a talent or foot-weight of water on the commercial scale	1	0·998 343
At Paris.		At 0° Cent. kilog.
Weight of 1 décimètre cube of dry air, bar. 760 mm. (Biot)		0·001 299
Weight of 1 décimètre cube of water in vacuo (nominally)		1

ALLOWANCE; OR ERROR ALLOWED.

ENGLISH STANDARD MEASURES.

In length and in capacity the error allowed in excess is the same as in deficiency. In weight-units and gas measures the error allowed in excess is double that in deficiency.

LENGTH :—

	Allowance in excess
In rod of 10 feet, and in 6 feet	0·01 inch
In 3 feet, 2 feet, and 1 foot	0·005 inch
In 1 inch to 0·01 inch	0·001 inch

CAPACITY :—

Allowance in excess in grain-weights of water.

	Grain-weights		Grain-weights
In bushel	280	In half-pint and gill	8
In half-bushel	140	In half-gill	4
In peck	70	In quarter-gill	2
In gallon	50		
In half-gallon	25	In bottle	10
In quart, or pint	10	In half-bottle	5

For gas-standards.

	Allowance in excess
10 cubic feet, 5 cubic feet, and 1 cubic foot dry test $2\frac{1}{2}$ and $\frac{1}{2}$	0·5 per cent. fast

Burette measures.

	Allowance in excess
10 cubic inches, 5 cubic inches, 2 cubic inches	1 grain-weight
1 cubic inch, 0·5 cubic inch, 0·2, and 0.1 cubic inch	0·5 grain-weight

WEIGHT :—

	Allowance in excess
In 56 pounds, in 28 pounds, and in 14 pounds	5 grs.
In 7 pounds, in four pounds, and in 2 pounds	2 grs.
In 1 pound, in 8 ounces, in 4 oz., in 2 oz., and in 1 oz.	0·25 grs.
In 8 drams, in 4 drs., in 2 drs., in 1 dr., and in $\frac{1}{2}$ dr.	0·05 grs.

In bullion :—

In 500 ounces, in 400 oz., in 300 oz., and in 200 oz.	1 gr.
In 100 ounces, in 50 oz., in 40 oz., in 30 oz., in 20 oz. . . .	0·25 grs.
In 10 ounces, 5 oz., 4 oz., 3 oz., and in 2 oz.	0·025 grs.
In weights between 1 ounce and 0·001 ounce	0·005 grs.

In burette measures, for specified weight of water :—

In bottle of 11666$\frac{2}{3}$ grains	6 grs.
In half-bottle	4 grs.
In 7000 grains, in 4000 grs., in 2000 grs., in 1000 grs.	4 grs.
In 500 grains, in 300 grs., in 200 grs .	2 grs.
In 100 grains	1 gr.
In 50 grains, in 30 grs., in 20 grs., in 10 grs.	0·5 grs.
In 40 ounces, in 20 ounces . . .	5 grs.
In 10 ounces, 5 oz., 4 oz., 2 oz. . .	2 grs.
In 1 ounce, and in $\frac{1}{2}$ oz.	1 gr.

Allowance: (French) Tolérance; (German) Remedium.

FRENCH STANDARD MEASURES.

LENGTH :—

	Allowance in excess or in deficiency
Double décamètre	3 millimètres
Décamètre	2 „
Demi-décamètre	1 „
Double-mètre, et mètre en métal .	0·2 „
Demi-mètre, et decimètre en métal .	0·1 „

CAPACITY :—

		Allowance in excess or in deficiency
Double litre contenant	2000 grammes	3 grammes
Litre	1000 „	2 „
Demi-litre	500 „	1·5 „
Quart de litre	250 „	1 „
Demi-quart	125 „	0·7 „
Seizième	62·5 „	0·5 „

Pour matières sèches.

La vérification se fait par moyen de la graine de navette ; les différences en plus ne doivent pas excéder un centième pour les mesures en chêne. Les différences en moins ne sont pas tolérées.

Pour bois de chauffage.

On ne tolère les erreurs aux membrures qu'en plus.

	Excédant toléré
Stère	5 millimètres
Double stère	8 „
Demi-décastère	15 „

WEIGHT. Extreme error allowable in excess only.

	In iron	In copper
In 50 kilogrammes	20 grammes	
„ 20 „	10 „	150 centigrammes
„ 10 „	6 „	80 „
„ 5 „	4 „	50 „
„ 2 „	2 „	25 „
„ 1 „	1 „	15 „
„ 5 hectogrammes	0·5 „	10 „
„ 2 „	0·3 „	5 „
„ 1 „	0·2 „	3 „
„ 5 décagrammes	0·1 „	2·5 „
„ 2 „	„ „	2·0 „
„ 1 „	„ „	1·5 „
„ 5 grammes	„ „	1 „
„ 2 „	„ „	0·4 „
„ 1 „	„ „	0·2 „

APPENDIX I.

PROPOSED ENGLISH COMMERCIAL SYSTEM.

HAVING set forth and arranged the commercial units of measure used by the greater part of the world, in the foregoing volume, and estimated the values of these units in accordance with English commercial measure at the modern normal standard temperature, in accordance with English scientific measure at 32° Fahrenheit, and in French units; the work is so far complete as to enable any one to refer to the foregoing tables for any detached commercial unit in Part I. and for any complete commercial system to Part II.

The English scientific system, hitherto deficient in several respects, has been rendered more perfect and complete, and is now available for employment in any scientific and technical work and calculation; the details are given in Chapter VI., Part II.; the system itself at page 408.

So far, the object of the book as a work of reference may have been attained.

This, however, has not been the sole aim of the laborious calculations, compilation, reduction, and arrangement. The rationale of formation, the origin and modes of development, the defects, advantages, redundancies and incongruities of various modern commercial systems and units of measure have been dealt with in the text, so that every possible light may be thrown on the subject of modern metrology without exceeding the limits of a single volume.

The reasoning and deductions need not necessarily be

barren talk, but should point to some practical and logical conclusion that may benefit the English-speaking millions who are at present heirs to a rather incongruous set of commercial measures; the *pro et contra* in the argumentation should certainly be borne in mind, but some useful result in the form of an improved English commercial system, drawn up by some one conversant with the whole subject, seems to be imperatively demanded by the public.

The author has therefore drawn up the following *proposed English system*, as a conclusion to the arguments before advanced.

If these arguments be recapitulated in broad and firm lines they may be generally thus expressed :—

1. A commercial system should be sufficiently comprehensive to meet the requirements of every trade; and its range should comprise the lowest and the highest values of units in common use.

2. A commercial system should rest on a scientific basis, and thus be thoroughly systematised throughout.

3. The basic units should be familiar to the people, and chosen from among such existing units.

4. Every secondary unit in the whole system should be capable of being conveniently and terminably expressed in terms of the basic units.

5. The mode of subdivision should be in accordance with geometrical formation, thus—in linear units, decimal, in surface units centesimal, in cubic units and in weight units millesimal. Any departure from this principle should alone be permitted at subsidiary points, where the customs of the people imperatively demand a binary or a mixed binary-decimal subdivision.

6. A strict correspondence should exist between the capacity units and the weight units, which should be formed on cubic measure, and the weight of water contained in cubic measure.

7. The changes introduced should be as few as a thorough systematisation can admit of: the amount of change in any old value of a unit should be generally less than that due to change of temperature.

8. The entire system should be as condensed as possible; all unnecessary and incongruous units being discarded.

These principles have been studiously observed in drawing up the following proposed English commercial system.

This, though probably better suited than any other to the wants of the English at the present day, cannot be considered as absolutely final, or as not susceptible of further improvement at some future time, when the habits of the people have changed to a greater degree. At such a period, the portions of the system that appear slightly incongruous, and are solely retained in deference to old custom in retail trade, may be further modified; but this can be then done without altering the framework of the system. Such portions can be best referred to when examining the whole.

The linear measures, it will be observed, are strictly decimal, with one exception; the mile, which is the old London mile of 5000 feet, in use for ages before the innovating statute-mile became obligatory, is exceptional, and might eventually be abolished, in favour of the league.

In the surface measures, the whole are centesimal with two exceptions, the acre and the square mile, which might eventually be discarded and supplanted by the rood, century, and square league.

The strictly cubic measures are perfect, but the capacity measures based on cubic measure still retain concession to old habits in retail trade; a gallon of 200 fluid ounces, and a fluid pound of 20 fluid ounces, would be otherwise preferable.

The measures of weight also might be correspondingly improved by similarly making the stone 200 ounces, and the pound 20 ounces.

The whole of these possible further improvements appear almost impracticable at present, for it seems necessary to keep both the pound and the gallon at some value very close to the present Georgian values; the same reason compels the retention of an acre and a mile.

For the present, therefore, the following simplified and concise English system may be considered as the utmost change practicable.

THE PROPOSED SYSTEM.

BASED ON THE ENGLISH SCIENTIFIC SYSTEM.

LENGTH.		Equivalent in Existing English Units
FOOT = 10 tithes = 12 inches	=	*1 foot*
Rod = 10 feet	=	*10 feet*
Chain = 10 rods	=	*100 feet*
Cable = 10 chains	=	*1000 feet*
Mile = 5000 feet = 50 chains	=	*5000 feet*
League = 10 000 feet = 100 chains	=	*10 000 feet*

SURFACE.

SQUARE FOOT = 100 sq. tithes = 144 sq. in.	=	*1 sq. ft.*
Square rod = 100 sq. ft.	=	*100 sq. ft.*
Square chain or rood = 10 000 sq. ft.	=	*10 000 sq. ft.*
Acre = 4 roods = 40 000 sq. ft.	=	*40 000 sq. ft.*
Square cable or century = 100 roods	=	*1 000 000 sq. ft.*
Square mile = 25 centuries = 625 acres	=	*25 000 000 sq. ft.*
Square league = 100 centuries	=	*100 000 000 sq. ft.*

CUBIC.

Cubic tithe, or fluid ounce	=	*0·001 cub. ft.*
CUBIC FOOT = 1000 cub. tithes = 1728 cub. in.	=	*1 cub. ft.*
Cubic rod = 1000 cub. ft.	=	*1000 cub. ft.*

WET CAPACITY (*in retail*).

Fluid ounce = 1 cubic tithe = 1000 fluid mils	=	*0·001 cub. ft.*
Fluid pound = 16 fluid ounces	=	*0·016 cub. ft.*
Gallon = 10 fluid pounds = 160 fluid ounces	=	*0·160 cub. ft.*

WET AND DRY CAPACITY.

Bushel or firkin = 1 CUBIC FOOT = 1000 fl. oz.	=	*1 cub. ft.*
Tun = 40 firkins or bushels = 40 cubic feet	=	*40 cub. ft.*

WEIGHT.

Ounce = 1000 mils	=	*0·001 ft.-wt.*
Pound = 16 ounces	=	*0·016 ft.-wt.*
Stone = 10 pounds = 160 ounces	=	*0·160 ft.-wt.*
FOOT-WEIGHT OR TALENT = 1000 oz. = 62½ pounds	=	*1 ft.-wt.*
Ton = 40 foot-weight or talents	=	*40 ft.-wt.*
Rod-weight = 1000 foot-weight	=	*1000 ft.-wt.*

APPENDIX II.

THE ACTUAL AND THE PROPOSED STANDARD TEMPERATURE AND PRESSURE.

On referring to the tables giving values of foreign commercial units, it will be noticed that in every case a French metric value, an English commercial value, and an English scientific value, are given.

The reasons for so doing are that the correct mode of comparing English and French units is a matter still open to consideration and grave doubt, and that either mode might not only be adopted in actual practice, but might also be made legal at any time. The reader can choose for himself, and the tables afford convenience, whichever may be his choice.

1. *The French Conditions.*—The French system is a two-temperature system, under a pressure of zero, or, as it is termed, a vacuum system; the temperatures are 0° Celsius, or centigrade, for the material of the standard, and 4° C. for the distilled water, through which measures of weight and of capacity and cubic measure are made to correspond. These are laboratory conditions tolerably convenient on the whole, owing their principal advantage to the absence of pressure and of any need for the consideration of air-displacement; but the two temperatures, one for the vessel or material, the other for the water, constitute a defect.

In French commercial transactions the litre and mètre are not used in vacuo at freezing-point, but in open air, under any pressure and at any temperature; no allowance is made either for pressure, displacement, or expansion; the small loss to the

seller in length, and the small gain to him by displacement in capacity and weight, being borne by him. His litre and mètre cannot be absolutely true and correct, except under the theoretical laboratory conditions under which they are formed, and under which they may be verified at any time.

Hence, to speak with exactitude, the true values of the litre and mètre are not used in actual trade; approximate values take their place. The materials of which measures are constructed are various, with different expansions, but the primary kilogramme and mètre are made of platinum. Thus the French in commerce disregard the whole of the discrepancies arising from local conditions and material, and the seller in any transaction, while submitting to the burden, can enhance his prices and recover from the buyer. This mode is probably on the whole the most convenient; and is certainly the best for all ordinary coarse purposes of trade.

The French law, however, confines this method to trade only, and wisely abstains from interference with the scientific man and his calculated results. It does not say to him, 'Thy mètre shall not expand,' or 'Thou shalt not calculate on the expansion of thy mètre.' Any such edict, whether imperial, papal, national, or bureaucratic, could only meet with a reply corresponding to the 'E pur si muove' of the distressed Galileo Galilei. Hence, practically, the French scientific man is in purely scientific matters exempt from the regulation to disregard the before-mentioned discrepancies.

It may also be noticed that the French do not and cannot lay down the law regarding the use in trade of French metric measures in countries beyond French rule; far less can they regulate details affected by temperature and local conditions. The country of adoption alone has the requisite regulative power, and that is necessarily then confined to trade alone.

2. *The English Commercial Conditions.*—The English commercial standards are now said to be correct *in air* under a two-temperature system, in which the material is at a temperature of 62° Fahrenheit, and the distilled water of comparison is taken at a maximum density temperature about 39°·4 F.

Probably this method has been too much extolled on account of its advantage of approximating to the mean conditions under which English trade weighing and measuring is conducted. Its historic accuracy is also in its favour, as our Anglian, Saxon, and Danish forefathers doubtlessly used open-air standards, and probably verified them at some grand annual gathering that would not have taken place in the winter season. The Georgian normal temperature was artificial and exceptional.

Great as the above-mentioned practical advantage may be, it is more imaginary than real : discrepancies due to change of temperature must exist, and it is of slight consequence whether they are a little greater or a little less in value ; while from a scientific point of view any and every open-air system is necessarily very clumsy and inconvenient, from the perpetual change of allowance to be made on account of altered air-displacement under different temperatures. The material used is brass, and sometimes bronze, or Baily's metal ; which mixed metals are scientifically inconvenient, on account of variety of expansion and of density in material nominally the same. But the principal monstrosity is the problem the system presents in requiring the gallon or other vessel-measure to be at a temperature of 62° F., while its contents, the distilled water, must be at about 39°·4 F., for actual correct verification. As this is manifestly impossible, recourse is had to theoretical compensating temperatures and calculated adjustment : this is a mode of avoiding the correct construction, but cannot be justly said to be doing it.

A system is most faulty that does not permit of direct and simple determination of every unit belonging to it.

If the English conditions included a temperature of 62° F. for the water as well as the material—that is, throughout—they would be more defensible in an open-air and a practical commercial system ; but as they are, they both fail greatly from a scientific point of view, and are defective in not sufficiently approximating to ordinary commercial conditions.

Some judicious alteration seems imperatively needed.

3. *The English Scientific Conditions.*—On account of the extreme clumsiness and incongruity in the English commercial conditions, a great number of scientific men in England have preferred adopting the simpler conditions of the French metric standards ; that is, a vacuum system, with the two temperatures, freezing for material, and that of maximum density for the water. It is of great convenience to them in many ways, especially in exact calculations, and has the advantage of keeping the values of English units exactly parallel with the French units. Having adopted as four basic units, the foot, the square foot, the cubic foot, and the foot-weight, and their decimal multiples and submultiples, under these conditions Englishmen can keep their scientific calculations as simple and clear as the French.

It may perhaps be said that such conditions are not legal ; and this is true in that English law does not yet acknowledge them. On the other hand, the law does not forbid them, and could not practically hinder their adoption in non-trading matters, even though a bureaucrat should arise that knew not the name of science.

The former Warden of the Standards, Mr. Chisholm, in his work on 'The Science of Weighing and Measuring,' refers to scientific and commercial units, and thus recognised the two distinct sets of conditions.

That it would be more advisable to have only one set of conditions in England both for scientific and commercial purposes, is a theory that may be true ; but assuming it to be correct, the trade should then not lay down the law for science, but should follow it, and adopt the conditions preferred by scientific men generally. In the meantime things remain as they are.

4. *Comparison of French and English Units.*—There are at present two distinct modes of comparing French and English units, and these two methods have each a strong array of supporters on various theoretical and logical grounds, in addition to the numerous backers that follow their own likes and dis-

likes: they may be briefly termed the expanders and the freezers.

The expanders believe that the French and English units should be compared in similar material at the same temperature and under the same conditions, and adopting the English commercial conditions as those of comparison in England, use the expanded mètre at 62° F., the expanded litre in air instead of in vacuo, and the rest of the metric units as they then would be under English conditions, although using such metric standards as were previously originally correct under French conditions. The expanders hence allow for expansion, air-displacement, and for every change in the value of French standards that has practically occurred in the transition from 32° in vacuo to 62° F. in air. They thus obtain the English *commercial* equivalents of French units; and correspondingly also reduce English commercial to French units in the converse way.

The former Warden of the Standards was a supporter of this method; and a great number of men have adopted it for a long time (since 1860); it appears logical, rational, and correct, although it is perhaps not so good as it seems.

The freezers adopt a different mode of comparison; they say the French mètre is a French mètre, by which they mean an abstract unit of length; and they either ignore or avoid expansion or allowance for change by thus denying the presence of material in the unit. They also explain with considerably better argument that the French metric system laid down by the French in vacuo at 0° and at 4° C., can be correct only under its own conditions. As also the corresponding assertion that the English commercial system can only be accurate under its own conditions is also true; the freezers arrive at the conclusion that the proper mode of comparison is to allow each system its own conditions, and to compare French and English units side by side under the diverse circumstances. The next thing to decide is, 'Can that be actually done?'

In a few special cases it can be done, for a frozen mètre can be placed by the side of an English yard heated to 62° F.,

and a linear comparison may be easily made; something similar might also be done with a surface-unit and a cubic unit of French and English measure.

When, however, it comes to attempting anything similar with either capacity-units or weight-units it seems almost hopeless.

The practical problem of comparing a frozen metal litre-vessel in vacuo, having water at 4° C., with a gallon at 62° F. in air, having water at its maximum density, is indeed too formidable. The comparison even of French and English weight-units seems to involve using a balance with a vacuum-chamber on one side and not on the other—a serious matter. The freezer's method hence fails, and recourse has to be had to calculation instead of practical determination. On what basis, then, can the calculations be made? If on the admission of expansion, the method fails; if on ignoring expansion altogether, the deductions must be faulty from a scientific view.

The results, however, of this method are the so-called English scientific equivalents of French metric units, in which expansion &c. is all ignored, and which necessarily commands the attachment of that very large category of persons that delight in trouble saved; that is, in a less amount of labour, with indifference to the intrinsic merits of the result. English enactment also supports this method, also a certain number of scientific men. Curiously, however, the commercial and trading communities and chambers seem by no means in its favour generally, but rather follow the expanders.

In consequence of these two methods being both in vogue, it has been necessary to give two English sets of equivalents, the commercial and the scientific equivalents of foreign units, throughout the whole of this book. It could not rest with the author to exclude either, as either might be required by anyone according to choice, and because the matter cannot yet be said to be definitively and permanently settled.

The conclusion to which the arguments of both the expanders and the freezers point is, that no just precise comparison between two such different systems as the French and

English in their original conditions is practically possible ; and that either system, when transmuted in any way, is spoilt. Hence the necessity for having some international conditions, fit for purposes of comparison, drawn up by scientific men of both nations ; also the further necessity for a single temperature instead of a double temperature in those conditions.

5. *Proposed Normal and International Conditions.*—The foregoing facts and conclusions lead to the belief that the temperature of maximum density of distilled water would form the best normal temperature for all systems or any system, as long as the method of comparing weight-units and capacity-units by means of water remains in vogue.

Such a single temperature could be applied equally well to metallic or other material, as it is now applied to water by universal consent.

Each nation could then declare its units and make its international standards on the basis of that temperature, and in vacuo ; difficulties of comparison would then cease.

On the same grounds it would also be advisable to reform the English conditions, and construct and verify English standards in vacuo, at a uniform and single temperature ;—that of the maximum density of distilled water.

This temperature has been lately re determined by a committee of scientific English investigators, in communication with the English Standards Department; the way for the change is therefore prepared, the step alone has to be taken.

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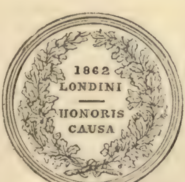

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